# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

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**AUGUST 1908.**

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## GENERAL PHYSICS.

**1222.** *Micrometer for Differences of Level.* **Gouy.** (Comptes Rendus, 146. pp. 1191–1193, June 9, 1908.)—A glass mirror 5 cm. thick and 30 cm. diam. is carried by a massive casting on a table. The top surface of the mirror is used as a plane on which a micrometer microscope slides about on three ivory feet. Supposing the surface is a true plane and is level—this arrangement serves the purpose of a cathetometer microscope of great mobility. It is used to measure surface tension by the method of large drops. The microscope is brought to read one level, then a vertical scale; next it reads a second level, and then the vertical scale; the difference in the two levels being thus determined. The surface of the actual mirror used, when examined officially, showed a concavity of 4 km. radius. The correction can thus be applied when required. P. E. S.

**1223.** *Studies of the Hypsometer.* **H. Mohn.** (Meteorolog. Zeitschr. 25. pp. 193–200, May, 1908.)—The author describes two hypsometers (spirit lamps, boiler, 40 mm. in diameter, 87 mm. in height, with two telescope domes and steam exit and thermometer on which a division of 1° has a length of 80 mm.) supplied in 1906 by C. Richter, of Berlin, and the testing of the instruments in 1906 and 1907 in Norway. The reference barometers were Wild-Fuess instruments, checked by comparison with an Adie Kew barometer. The results are very satisfactory. Accidentally the boiler was left uncharged once, but during 1907 the hypsometer kept constant. In 1906 some mercury had evaporated without causing a visible deposit; according to Bandin this evaporation has to be allowed for as proportional to the number of times the thermometer is heated to boiling-point. The mean error of the thermometer does not amount to more than ±0·00054°, and the air pressure is correct within ±0·015 mm., the hypsometer is thus three times more exact than a barometer. Independent hypsometer observations by A. S. Steen were also satisfactory, and the instruments are recommended for air-pressure and height determinations and gravitation corrections. H. B.

**1224.** *Pitot-tube Determinations of Velocity and Pressure in Water Pipes.* **W. B. Gregory** and **E. W. Schoder.** (Amer. Soc. Mech. Engin., Proc. 30. pp. 501–519, May, 1908.)—The results of tests of the distribution of velocity in a horizontal 6-in. pipe having a right-angle bend of 2 ft. 6 in. radius, by means of a Pitot tube, are given. As the water passes round the curve, the max. velocity tends towards the convex side, except at about $22\frac{1}{2}°$ from the commencement of the curve, where the max. is nearer the inner side of curve. The distribution is nearly symmetrical above and below the central plane. The pressures are at a max. at the convex, and minimum at the concave side of the bend. The exact distance below the bend at which any distortion in the distribution of velocity still remains was not determined, but none was detected at a distance of 88 ft. (76 diams.). In the long, straight pipe the distribution of velocity is practically an ellipsoid of semi-major diam. $a$, plus a rectangle of length of side $a$. On this assumption a good distribution of 10 or 20 points at which observations should be taken is on concentric circles whose areas are in arithmetic progression. The method on which the investigation is founded is as follows: $h$ is the head shown by Pitot tube pointing upstream, over that indicated by wall piezometer; $h_1$ is the corresponding suction head with Pitot tube pointing downstream. Then $v_1/v = \surd[(h_1 + h)/h], = 1{\cdot}133$ by experiment. Therefore $h_1 = 0{\cdot}0044\,v^2$. The first formula gives the true velocity $v$ at the point, and the second the value to be subtracted from the observed gauge-difference with the Pitot tube direct and reversed in order to obtain the pressure at the point. F. R.

1225. *Decay of Oscillations.* **H. Bouasse** and **Z. Carrière.** (Annal. Chim. Phys. 14. pp. 190–224, June, 1908.)—An analytical study of the decay of torsional oscillations of a wire is made, upon various assumptions as to the nature of the stress-strain curve. Working upon a particular sample of iron, it is established that permanent deformation always results in a subpermanent increase of "internal friction," and a permanent effect which may be either an increase or a decrease according to circumstances. The term "internal friction" is not used as an exact description of the cause of the phenomenon of decrement of oscillation. Two methods of experimenting were utilised and compared: (1) Observing decrement, as ratio ($\delta$) of loss per oscillation to the amplitude; (2) observing the additional throw (J) which must be given in order to maintain a constant amplitude. (1) is in general more convenient, and has the advantage of straining the sample less, and less frequently, than (2). The amplitudes used were generally sufficient to produce some overstrain in the wire. For annealed iron the curve representing $\delta$ as a function of the angle (A) of oscillation, commencing with a large value of A, gradually falls to a minimum, rises to a maximum, then tends towards a low value. Decrement in this form is considered a very artificial notion, founded by Coulomb on an erroneous theory of the causes of the absorption of energy. The decrement for the same amplitude for wires which have been permanently elongated in tension, decreases considerably with lapse of time. This is a much larger effect than the decrease due to repetition of torsional stress alone. The amount of the decrement shortly after tensile straining increases with the elongation which the wire has undergone, but decreases more rapidly the greater this elongation. It is useless to expect definite quantitative information in this direction; the curve of decrements is at most only a sensitive indicator of internal changes. An increase of decrement is brought about by elongation produced by winding the wire in tension upon and unwinding it from a cylinder, or by rolling it to a smaller cross-section, or by overstraining it in torsion. A wire annealed at a high temperature, and tested at atmospheric temperature after a long rest, has 20 per cent. less decrement than after heating up to 100° and again testing at the ordinary temperature. This effect is in the opposite direction to that already mentioned for overstrain. Hence the effect of heating to 100° a wire which has been permanently elongated depends on the amount of elongation; in the author's experiments with less than 4 per cent. elongation, heating to 100° increased the decrement at 15°, and with more than 4 per cent. heating to 100° decreased it. The decrements for wires in the normal condition and some which had been equally elongated in tension were greater at atmospheric temperature than at 100°. Wire as drawn has a lower decrement than the same wire after annealing, being nearly half for the same amplitude. As drawn the decrement is greater for the wire at 100° than at 15°. A rough trial indicated that the decrement was less for a magnetised wire than for the same wire unmagnetised. F. R.

1226. *Influence of Gaseous Medium on Friction.* **F. Charron.** (Comptes Rendus, 146. pp. 1013–1014, May 18, 1908.)—A copper brush presses against a rotating brass cylinder moving in a slow current of various gases. If the friction in dry air is 26, that in ordinary air is 25, in moist air 22, in air charged with benzene vapour 20, and with alcohol vapour 19. Dry hydrogen, $CO_2$, or ethylene produce no such effect. E. E. F.

1227. *Euler's Theory of Struts.* **H. Lorenz.** (Zeitschr. Vereines Deutsch. Ing. 52. pp. 827–831, May 23, 1908.)—An examination of Euler's theory shows that the formula may be applied to long struts with sufficient accuracy within the elastic limit of the material, and that the expressions, which follow from the analysis, for the deflection and stresses can be used if the difference between the length of the strut and the length of the chord (*i.e.*, straight line joining the two ends of strut) be taken into consideration. Incidentally it is shown that for equal small loads in excess of any of the critical loads nearly equal bending stresses are set up. The shear stresses are only of importance in relatively short struts. F. R.

1228. *Behaviour of Steel in Rolling.* **Haedicke.** (Stahl u. Eisen, 28. pp. 846–848, June 10, 1908.)—A brief outline of the probable deformation and elongation of a piece in passing through the rolls is given. The reheating which some observers say is visible as a piece is deformed in the rolls or forging press is stated also to occur with the compressed-air-driven hammer of Bêché and Gross, which is designed to maintain the max. pressure of the blow for a definite short period. Diagrams of the pressure in forging with a hammer of this type and one of the usual construction are given. F. R.

1229. *Influence of Proportion of Water on Cement and Concrete.* **Brabandt.** (Centralblatt der Bauverwaltung. Engineer, 105. p. 503, May 15, 1908.)—Results of tests on 30-cm. cubes, made according to the Deutsche Betonverein specifications but with varying proportions of water, are given, and the following conclusions are drawn: For ordinarily used concrete mixtures, the most favourable quantity of water is about 15 to 20 per cent. of the volume of cement and sand. Poor mixtures need less, rich mixtures need more (up to a max. total of 30 per cent.) water. The moisture contained in the raw materials, and the amount that will be absorbed by the aggregates, must be allowed for. In cold seasons less water, and in warm seasons more water is required. For important work the amount of water necessary should be determined by tests, and in general it is desirable to regulate it by specifications. F. R.

**1230.** *Report of the Reichsanstalt for* **1907.** (Zeitschr. Instrumentenk. **28.** pp. 101–106, April; 139–157, May, and pp. 172–189, June, 1908. Extract from the Report of the Kuratorium of the Reichsanstalt, March, 1908.)—Brief accounts of each important piece of work completed during the year are given, and references to the year's published papers of the Reichsanstalt and members of the staff. Abstracts of a number of these have already been given from the originals, and are therefore omitted here. Very low pressures of the order of from $10^{-6}$ to $10^{-8}$ mm. were measured by means of a metal diaphragm fitted with a Fizeau interference apparatus. The velocity of sound in pure dry air at 0° found by the resonator method is 33,192 ± 5 cm. per sec. For measuring expansion at high temperatures the sample is built in as part of the length of the inner of two concentric quartz-glass tubes, and the difference of expansions measured directly by microscope. The total expansion of platinum between $-188°$ and $+16°$ is from $1{,}594$ to $1{,}610\mu$ per m., and between $-78°$ and $+16°$ it is $809\mu$ per m. The apparatus used in the determination of the saturation pressure of water vapour above 100° can also be used for the measurement of heat of vapourisation. The water is heated electrically, and temperatures measured by Pt-resistance thermometers. The increase of volume of mortars and cements made in 1904 or 1905 was of the same order in 1907 as in 1906. It was noticed that a large part of this increase occurred in May, when the laboratory was no longer heated artificially, and partly lost again in autumn when the heating of the laboratory was resumed. The relative alterations of four standard manganin resistances were within the same small limits as heretofore, and the effect of atmospheric moisture was very slight, if anything. An important source of error in the silver voltameter has been found to be the variation of temperature between the electrode and the atmosphere. Working in a constant-temperature room this has been avoided, and consistency has been obtained in determinations of the e.m.f. of the standard cadmium cell. The necessary conditions for successful kathode deposition of highly reflecting metallic mirrors are: (1) The operation must be carried out in a chemically indifferent, dry atmosphere—this has been best secured by the use of cocoanut charcoal in preference to the mercury pump, and the atmosphere may be hydrogen and nitrogen or argon; (2) direct current must be used. The difference between the effects of a commuted direct current and an alternating current are being further investigated. The improvement in the magnetic properties of cast steel obtained by annealing at relatively high temperatures, 840° to 1,000°, is partially lost with lapse of time—say 6 months—at atmospheric temperature. Measurements made with radiation pyrometers showed that their indications differ considerably from what would be expected according to the Stefan-Boltzmann law; this is attributable to selective absorption in the fluorspar lens and by the junction of the thermocouple used. The determinations of the melting-points of Seger Cones have been carried as far as No. 20. A method is developed for measuring the imperfections of optical surfaces, by measuring by the interference method the thickness of the layers of air between successive pairs of faces from a set of three. F. R.

**1231.** *Hydrodynamic and Magnetic Analogies.* **A. P. Wills.** (Phys. Rev. **26.** pp. 220–247, March, 1908.)—Instead of the Bjerknes analogy, in which velocity corresponds to flux, specific momentum to field intensity, and specific volume to inductivity, the author proposes what he calls a "change-of-state analogy," in which velocity corresponds to field intensity, specific momentum to flux, and density to inductivity. The forces turn out to be opposite in sign to the observed electric and magnetic forces. This same irregularity appears in the Bjerknes analogy. But the new analogy permits of the assignment of a steady state of motion to the hydrodynamic system, consequently the analogy is one which will persist with lapse of time and without loss of generality. In this respect it possesses an advantage over the Bjerknes form of the analogy. E. E. F.

**1232.** *Wind Pressure.* **T. E. Stanton.** (Nature, 78. pp. 79–82, May 28, 1908.)—At the National Physical Laboratory the constant $k$ in the "equivalent" pressure-velocity notation $p = kV^2$ was determined by means of large vertical surfaces mounted on the top of an observation tower 50 ft. high. The velocity of the wind was determined by means of a Dines tube distant 10 ft. from the edge of the plate. The results of experiments on three plates, of areas of 25, 50, and 100 sq. ft., gave identical values of $k$, which in units of lbs. per sq. ft. and miles per hour was found to be 0·0032. In plates smaller than 1 sq. ft. Eiffel found the value to be 0·00285. To test the possibility of predicting the resistance of a complex structure in the wind from observations on a small-scale model, a model lattice girder was constructed of wood, with a span of 30 ft., and a reduced model of this in brass, forty-two times shorter. The resistance per area was 18 per cent. greater in the larger than in the smaller girder, just as might have been expected. Resistances of complex structures can be safely predicted from small models. When wind blows against a roof the greatest pressure is the outward pressure on the leeward side when the roof is open to the windward. E. E. F.

**1233.** *Soaring of Birds.* **M. Deprez.** (Comptes Rendus, 146. pp. 797–800, April 13; 1003–1004, May 18, and pp. 1299–1302, June 22, 1908.)—The "soaring" of birds, *i.e.*, maintaining themselves stationary above a given point without flapping their wings, is explained by a slight inclination in the direction of the wind, which gives a vertical component balancing the weight of the animal. The author has constructed a model illustrating this action, which is particularly noticeable in curved surfaces. The construction of a flying machine which utilises the wind in this manner is theoretically possible. [Langley explains the soaring by the short waves or ripples of the air, which the bird utilises in alternate directions.] He next calculates the ascending force yielded by a wing by reducing it to the pattern of a Venetian blind as employed by Maxim. If $s$ is the section of the channel formed by two consecutive elements of the blind, V the speed of the air current at entering, $\alpha$ the angle between the element and the horizon at entrance, $\alpha'$ the corresponding angle at exit (the element being curved), and $\mu$ the mass of 1 m.$^3$ of air, the vertical force is $\mu sV^2 (\sin\alpha' - \sin\alpha)$ and the horizontal force $\mu sV^2 (\cos\alpha - \cos\alpha')$. These two formulæ contain the solution of all problems concerning the aeroplanes of Maxim's type. The only experimental coefficient required is $\mu$, which is known with great accuracy. The efficiency of a wing can be calculated if we know its $s$. The max. speed at which a bird can soar against the wind is the greater the smaller the angle which the wing makes with the horizon. Birds with large wings can surpass the speed of the wind itself. E. E. F.

**1234.** *The Study of Evaporation.* **A. Woeikow [Voeikov].** (Monthly Weather Rev. 36. p. 63, March, 1908.)—F. H. Bigelow [see Abstract No. 19 (1908)] found that the formulæ of Stelling and of Abassia for the evaporation gave results differing as 2 : 1 for the same temperature, humidity and wind. The probable reason, the author points out, is that the wind was assumed to be the same at the different levels, the anemometers being all fixed on the top of the towers. Similar discrepancies were observed at Pinsk and Vasilivichi in 1897, two places 100 km. apart, under apparently equal temperature, humidity, and wind velocity conditions. Pinsk lies much more exposed near marshes than Vasilivichi near forests; but at Pinsk the evaporation screen is near a thick growth of trees, while at the latter place the screen stands free. H. B.

1235. *Predetermination of the Path of a Cyclone.* **F. J. B. Cordeiro.** (Meteorolog. Zeitschr. 25. pp. 201–206, May, 1908.)—The author likens the cyclone to a gyroscope, as he had at greater length done in his "Popular Astronomy" of 1907. We have to deal with surface friction and with centrifugal and gyroscopic accelerations; if these latter two balance one another the cyclone will keep on a degree of latitude—not deviating either to N. (to which the gyroscopic forces would urge it), nor to the S.—in what is known as the Poinsot movement. The tangent law deduced is tested with regard to a cyclone studied by Redfield and Reid, the originators of these researches. This cyclone passed from Sept. 27 to Oct. 10 (year not stated) over the West Indies, crossing Yucatan and the United States a little north of Florida; the law does not answer so well for the land path as for the sea path. Observations at two points enable us to say, in which latitude the cyclone will attain the same horizontal component of the velocity as the earth; in this latitude the motion towards the west will change into easterly motion. If that latitude is not reached, the cyclone will not turn. When the polar component of the velocity is also known, the exact path can be predetermined; that requires very careful observations at three points which are near to one another. In the case in question the cyclone moved practically E.–W.—*i.e.*, it attained its Poinsot motion—after reaching the 37° lat. As it could not cross this latitude, its energy cannot have been great; the energy is presumed to be fairly constant in this deduction. H. B.

1236. *Accidental Variations in Atmospheric Pressure in the United States.* **A. J. Henry.** (Monthly Weather Rev. 36. pp. 53–56, March, 1908.)—The author has examined the auxiliary 12- and 24-hour weather charts of the United States for the last twenty years. The maps concern the periods 8 to 8, and thus approximately day and night for the 75th meridian. Areas of pressure and fall and rise move generally across the United States from W. to E., a falling-pressure region being as a rule followed by a region of rising pressure; sometimes two depressions follow one another and merge into one. There are in addition stationary rises and falls. The amplitude of the fall does not bear any definite relation to the amplitude of the rise on the succeeding area; areas of falling pressure do not necessarily result in the formation of cyclones. The average 12-hour rise during the night hours was 0·32 in., and during the day 0·35 in. (40 cases); the average 12-hour fall was 0·31 in. during the night, and 0·32 in. during the day (45 cases); thus these differences between day and night are small. The following conclusions are arrived at from a study of the areas of rising and falling barometers: A strong 12-hour fall (0·6 to 0·9 in.) on the N. Pacific will have moderated down to 0·2 or 0·4 in. by the time it reaches the Mississippi Valley, the attendant cyclone diminishing in strength. The areas of pressure-fall that attend severe cyclones in the E. of the United States begin as moderately shallow areas, mostly circular (not elliptical), and may suddenly increase in strength. Two separate pressure-fall areas moving to the E. along different paths are apt to unite in the Mississippi Valley to an area characterised by a greater amplitude of fall than in the single areas. Areas of rising pressure whose origin is apparently over the Pacific Ocean do not produce severe cold in their motion across the continent. The unusually frigid weather is almost invariably preceded by areas of rising pressure coming from the N. or with a strong northern component; the degree of cold that will follow any cyclone depends on the geographic position of the succeeding anticyclone. The principal entrance of the cold winds is along the northern border between the eastern slope of the Rocky Mountains and Lake Superior; they flow southerly in shallow surface currents whose vertical extension is at no time great enough to permit the cold air to stream westward through the low passes of Wyoming and Colorado into the Great Basin. This was observed by F. H. Loud on Oct. 24, 1907. The rapid southward flow of extremely cold air is one of the striking characteristics of the winter climate of the Mississippi Valley and the Plain States; it is mostly cooling by cold air transport, supported by radiation. H. B.

**1237.** *The Vertical Temperature Distribution in the Eastern Mediterranean.* **J. Hann.** (Meteorolog. Zeitschr. 25. pp. 215–219, May, 1908.)—In his "Handbuch der Ozeanographie" Krümmel assumes that the solar heat penetrates to depths of 300 m. in the Western Mediterranean and to 500 m. in the Eastern Mediterranean. The author shows at some length that temperature fluctuations to such great depths are inadmissible and not in accordance with the observations published by the Deutsche Seewarte, by the London Meteorological Office (Monthly Pilot Charts), and by the Pola Expedition of 1890–91. In the Ionian Sea and N. of Egypt the vertical temperature circulation is confined to the upper 100 m.; between 500 and 2,000 or 3,500 m. the temperature remains almost constant at 13·5 or 14° C. owing to the advection, the slow nearly horizontal gliding of the cold water coming from the northern shores of the Mediterranean; between 100 and 500 m. the temperature is the result of conduction which has continued for centuries. The values of the annual and daily heat exchanges confirm these conclusions. In making their estimates Aimé and Knott found that the daily heat fluctuations were in the Mediterranean confined to the upper 20 m.; Knott's estimate of 450 ± 50 gm.-cals./cm.$^2$ for the lat. 33° in the Mediterranean agrees with J. Schubert's 440 gm.-cals. for the Paarsteiner See, Lat. 53° N.; both refer to September, and Knott's figure is probably a lower, and Schubert's an upper limit. H. B.

**1238.** *Influence of the Mean Temperature of an Air Column on the Air Pressure at the Base.* **H. v. Ficker.** (Meteorolog. Zeitschr. 25. pp. 222–226, May, 1908.)—The author had proved that the wedges of high pressure on the northern slopes of the Alps are effects, not of dynamical, but of thermal causes; the air is not stopped by the Alps, but the column charged with cold air. Trabert [see Abstract No. 714 and also No. 888 (1908)] had shown that this explanation holds also for the wedges of high pressure south of the Alps. These high-pressure wedges do not always go together with colder air, however; sometimes—*e.g.*, on Dec. 15 and 16, 1902—the temperature rises. The author, therefore, shows that there may be a temperature-rise near the surface, but colder air higher up. The deductions concern the districts both north and south of the Alps; the mountains can only be crossed at an altitude of about 8,000 m., and thus, in ordinary conditions, only by cold air. Cold air may also rest all over the Alps, and yet the barometer fall on the Sonnblick. If the pressure and temperature decrease simultaneously near the surface, there must be a temperature compensation in the higher strata. Barometer- and temperature-falls sometimes occur simultaneously at Innsbruck when relatively thin strata of cold air pass under the Föhn. In how far analogous conditions may prevail in the upper atmosphere, we have yet to learn from balloon observations. H. B.

1239. *Determination of the Règime of Rivers and of the Dnĕpr.* **E. V. Oppokov.** (Acad. Sci. St. Pétersbourg, Bull. 10. pp. 805–818, June 1, 1908.)—The quantity of the flow of Russian rivers has so far only been studied by A. Heintz for the upper Oka (1884 to 1897) and for the basin of the upper Dnĕpr and its tributaries above Kiev by the author (1876 to 1907). The author believes that observations of the water level, of the rainfall, and of the temperature, if continued for a sufficient number of years (25 or 80 at least, according to Kröhnke) suffice for determining the *régime* of a river. He carried this out for the basin of the Pripiati in 1898, and in 1904 for the basins of the Desna and the upper Dnĕpr. In the present paper the latter observations are completed and analysed. Evaporation is mentioned, but observations on it are not given; run-off and penetration into the soil are not considered, except in the conclusions. H. B.

1240. *Helium in the Atmosphere.* **J. W. Evans.** (Nature, 77. p. 585, April 9, 1908.)—Discusses the possibility of helium being lost to the earth or concentrated at a certain level in the atmosphere. Gases do not distribute themselves uniformly in the atmosphere, but to a certain extent take up positions according to their relative densities. Jeans calculates that if helium forms a millionth part by volume of the air at sea-level, it must amount to more than 2 per cent. at a certain altitude dependent upon temperature. When we can calculate the approximate amount of free helium, we can arrive at some conclusion respecting the disintegration of rocks. E. E. F.

1241. *The Tores of Saturn.* **P. Lowell.** (Phil. Mag. 15. pp. 468–477, April, 1908.)—The view indicated by the title of this article has already been advanced by the author in a brief popular article elsewhere [see Abstract No. 212 (1908)]. Both in June (19th) and Nov., 1907, when the rings of Saturn were almost edgewise to the earth, a curious detail was observed at Flagstaff in the shadow of the ring on the planet. The band of shading on the whole was only moderately dusky—"seemed almost to belie its function because of the lack of density it offered to the eye"—but it was cut across by a narrow black line about one-fourth its total width. On Nov. 5 the band was noted as tinged a faint cherry-red, rather more strongly so than the planet's own belts. The black medial line was by no means even. It both undulated slightly and showed irregularities of outline, one black head especially being noticeable about half-way from the planet's centre to the eastern limb (Nov. 13, 14h. G.M.T.). The line on the same occasion seemed not quite central in the belt, but a little nearer the northern edge. Although seen by all the observers at Flagstaff, the black core has not been reported from the Lick or Yerkes—a fact claimed as proof of the superior definition at Flagstaff. On June 19 the rings themselves could with attention be made out as the finest knife-edge of light cutting the blue of space on either side the planet's disc. As the sun was then 82′ north of the ring-plane, while the earth was 2° 16′ south of it, this fact is taken as showing that the rings are never wholly lost in the Flagstaff glass. In Nov. the rings were equally visible, in fact were easy objects. In addition to the general line of their light, agglomerations were plainly discernible on them, when attention was directed thereto. The agglomerations were symmetrically placed, two on either side the ball, and continued observation showed them to be permanent in position. Micrometric measures were made upon them from Nov. 8 to Nov. 9. The author's measures on Nov. 9, 15h. 25m. to 15h. 50m. G.M.T. gave for the distances from the nearer limb: Right inner thickening, 1″·00–3″·94; outer do., 6″·92–8″·51. Left inner thickening, 1″·15–4″·22; outer do., 6″·53–8″·46. Measures of the whole ring were also made, giving at most 2·19 radii of Saturn for the breadth. It thus appears that the ring could not be followed quite to the outer limit of ring A, which stretches to 2·25 or 2·30 radii from the planet's centre. It is inferred that the outer part of ring A has less thickness than the rest. Seeliger's remarks are quoted respecting the observations made in 1891, the last occasion on which the rings were edgewise to the earth, and his conclusion as to the cause of the agglomerations is disputed, being said to give results in disagreement with the new measures. Since the present article was written Barnard has published his observations with his explanations. They are referred to in a footnote as follows: "His [Barnard's] explanations, however—for he gives two—one that the eye sees through the underside of the rings, and that such light is greatest where the rings are densest, the other the exact opposite, that the light is most where the ring is least crowded—are self-condemning on several counts; one, for instance, that the inner condensation does not fall by his own showing on the ansal position of any part of ring A, but wholly on the crape ring. Each explanation might possibly account for one agglomeration alone, but for that very reason fails for both together. The presence of the gaps is another fatal objection to them." . . . "As seen at Flagstaff, their [the agglomerations'] vertical width was about 0″·20, while that of the continuous ring was about 0″·02, giving for the width of the main plane of the rings some 80 miles or 130 km." As in the previous paper the endeavour is here made to account for the observed phenomena by supposing Saturn's rings to contain portions of the shape of tores or anchor rings, formed by the disturbing action of Mimas, Enceladus, and Tethys on the constituent particles. A. E.

**1242.** *Apparent Dispersion of Light in Interstellar Space.* **P. Lebedew.** (Comptes Rendus, 146. pp. 1254–1256, June 15, 1908.)—Nordmann and Tikhoff explain their interesting discovery, that the epoch of minimum of a variable star observed in the red rays of the spectrum is some minutes in advance of the minimum observed in the violet rays, by assuming that in interstellar space light undergoes a dispersion which is comparable to the dispersion in atmospheric air at 7 mm. pressure and 0° C. [See Abstracts Nos. 590, 591 (1908).] This explanation, simple as it may appear, has, says the author, the drawback of being in contradiction to the facts of Modern Science. We cannot attribute the said dispersion to an ordinary gaseous medium in which dispersion is intimately allied to absorption, because the theory of light [see Planck, Abstract No. 1909 (1904)] would exact in this case an absorption so great that we would not be able to see the stars, nor even our sun; neither can we attribute this *rôle* to the ether itself without upsetting all our electromagnetic theories. Nordmann's discovery can be explained without recourse to the dispersion of light in space if we seek the cause of the difference of epochs in the physical properties of the variable star. Astrophysical researches show that (in the cases in point) the variations of brightness are due to the passage of a satellite before the star; and the difference in the enfeebling of the light in different regions of the spectrum [see Schwarzscheld, Publ. d. Kuffner. Sternwarte, 5, 1900, and Tikhoff *loc. cit.*, p. 165] shows that the satellite is surrounded by an extensive gaseous atmosphere which absorbs the light of the central star. It is sufficient to make the hypothesis that the atmosphere of the satellite is distributed a little asymmetrically in relation to its centre, and displaced in the direction of its orbit; the asymmetry may be the result of axial rotation and heating by radiation from the central star; the difference of the epochs of the minima for the red and violet light then follows as a natural consequence. A parallel case is realised in our own solar system for an observer on the moon during an eclipse; the epochs of minima observed for wave-length $6{\cdot}5\,\mu$ (absorption band of water-vapour in the infra-red) and for wave-length $0{\cdot}5\,\mu$ (transparent) would be different, because the humidity of the terrestrial atmosphere is greater on the evening side than on the morning side. The difference of epochs in the last-named instance would not exceed a fraction of a second; but in the case of the extensive atmosphere of a satellite revolving in the immediate vicinity of its primary, the perturbations would be much larger, and two rays of light unequally absorbed in this atmosphere might give minima with epochs differing by some minutes. Even if the dispersion of light in interstellar space had the enormous value admitted by Nordmann, his discovery cannot serve as a basis for investigating the said dispersion, because the method depends upon the hypothesis that the atmospheres of the satellites of variable stars are rigorously symmetrical, a hypothesis incapable of independent verification. A. E.

**1243.** *Mean Star-Density at different Distances from the Solar System.* **J. C. Kapteyn.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 626–635, April 24, 1908.)—A previous paper (ibid., April 20, 1901) gave not only the so-called luminosity curve, but also the law according to which the star-density (*i.e.*, the number of stars per unit volume) diminishes with increasing distance from the solar system. It was expressly stated that the determination of the law of density was merely provisional, pending the accumulation of data relative to the numbers of the stars of different magnitudes and their mean parallaxes. Since then all the accessible materials relating to the numbers of stars have been treated (see Pub. of Astron. Lab., Groningen, No. 18), and by their aid alone it has been found possible to effect an improvement in the distribution of densities for the larger distances, though information as to the parallaxes is still lacking. A separate treatment of the different regions of galactic latitude has not yet been attempted, the object of the present investigation being merely to get first notions as to the density at the greater distances. It is assumed that there is no absorption of light in space. In the Astron. Journ., No. 566, analytical expressions were derived to represent the numbers found in the above communication. The expression there given for the law of luminosity has been adopted without change, viz., $\psi(\mathrm{L}) = \frac{a^2.\,\mathrm{mod.}}{\sqrt{\pi}\mathrm{L}}\, e^{-a^2(\log \mathrm{L} - \mathrm{T})^2}$, where $\mathrm{T} = 1{\cdot}400$, $a^2 = 0{\cdot}385$, $\mathrm{L} =$ luminosity ($\mathrm{L} = 1$ for sun), and $\psi(\mathrm{L}) =$ probability that the luminosity lies between $\mathrm{L} \pm 1/2$ mag. The density curve, however, is discarded, and a new determination obtained by the aid of the numbers of stars of various magnitudes, employing the formula $\mathrm{N}_m = 4\pi \int_0^\infty \rho^2 \Delta(\rho) \psi(h_m \rho^2)\, d\rho$, where $\mathrm{N}_m =$ number of stars between the magnitudes $m - 1/2$ and $m + 1/2$, $\rho$ = distance from solar system ($\rho = 1$ for parallax 0″.1), $\Delta(\rho)$ = star-density at distance $\rho$, $h_m$ = apparent brightness of a star of mag. $m$, ($h_{5.5} = 1$). By aid of this formula $\Delta$ is derived as a function of $\rho$ from the *given* values $N_m$ and the *given* form of $\psi$. The line of investigation adopted is to seek to determine the luminosity curve directly on the assumption that for the distance intervals 0 to 10, 10 to 30, 30 to 50, and 50 to $g$, the density changes linearly in such a way as to vanish for $\rho = g$. With the further assumption $\Delta(10) = 0{\cdot}97\Delta(0)$, the problem is thus reduced to the derivation of the 4 unknown quantities $\Delta(0)$, $\Delta(30)$, $\Delta(50)$, $g$. By transformation the expression for $N_m$ is reduced to the well-known integral form $\Theta(z)$. Numerical integration is thus avoided, and linear relations are obtained between the new unknowns. The solution was performed for the values 400, 600, 800, 1,000 of $g$, but only the last gave satisfactory results, and the results communicated were obtained with the adopted constant $g = 1{,}000$. From the values of the densities given by the solution of the equations of condition the numbers $N_m$ were computed. Comparison of these computed numbers with the observed numbers shows that the deviations are less than the uncertainties of observation. The following table may give some insight into the distribution of stars of various magnitude as regards distance :—

NUMBERS OF STARS.

| $\rho$ = Distance. | Mag = 3. | 7. | 11. | 15. |
|---|---|---|---|---|
| 0 to 10 | 108·0 | 4,770 | 42,000 | 60,000 |
| 10 to 30 | 45·5 | 8,340 | 286,000 | 1,080,000 |
| 30 to 50 | 5·5 | 2,350 | 144,000 | 1,250,000 |
| 50 to 1,000 | 2·5 | 8,000 | 885,000 | 56,150,000 |

The conclusion is reached that the numbers of stars of different magnitudes (Harvard scale) as given in Pub. of Groningen Lab., No. 18, are well represented by adopting the above luminosity curve and the following values of the star-density :—

STAR-DENSITY.

| $\rho$ | $\Delta$ | $\rho$ | $\Delta$ |
|---|---|---|---|
| 10 | 0·970 Δ(0) | 200 | 0·111 Δ(0) |
| 30 | 0·460 ,, | 400 | 0·083 ,, |
| 50 | 0·131 ,, | 600 | 0·055 ,, |
| 70 | 0·129 ,, | 800 | 0·028 ,, |
| 90 | 0·126 ,, | 1,000 | 0·000 ,, |

$\Delta(0) = 189{\cdot}7$.

[The two tables are abbreviated (by half) from the original.] A. E.

## REFERENCES.

**1244.** *Orbit of α Andromedæ.* **Ludendorff.** (Astronom. Nachr., No. 4250. p. 23, May 21, 1908. Nature, 78. p. 136, June 11, 1908. Abstract.)—From spectrograms taken during 1901–7 the period is found to be 96·7 days. C. P. B.

1245. *Pendulum Interrupter.* **G. Eichhorn.** (Schweiz. Elektrot. Zeit. 5. pp. 173–174, April 11, 1908.)—A modification of Helmholtz's pendulum interrupter, in which the range of measurement is considerably increased, all retardations are avoided, the pendulum is worked from the place of the telescope, and no strong electromagnets or moving masses of iron are used. The pendulum has the shape of a brass quadrant. The range of measurement of time intervals is from half a second to a millionth. E. E. F.

1246. *Solid Angles.* **L. Weber.** (Zeitschr. Instrumentenk. 28. pp. 129–136, May, 1908.)—Describes at some length two new methods of measuring solid angles. In the first method, which is adapted for determining areas on the surface of a sphere, use is made of the pantograph to obtain (i.) the projection of a given area on some fixed plane (say the horizontal plane), and (ii.) the projection of the central section parallel to this plane. From a comparison of these two the area on the sphere can be determined. In the latter part of the paper a modified form of Moritz apparatus is described. A. W.

1247. *Zoopteric Helices.* **P. Amans.** (Comptes Rendus, 146. pp. 656–659, March 23, 1908.)—Studies animal or wing helices by means of the anemometer. These are more efficient than geometrical helices. Their surfaces are concave below, the curvature diminishing from front to back. The author gives an empirical formula for the traction obtainable from a partridge wing. The anemometer and the dynamometer give comparable results. E. E. F.

1248. *Meteorology of Russia.* **A. Woeikow [Voeikov].** (Monthly Weather Rev. 36. pp. 61–63, March, 1908.)—Voeikov gives abstracts of memoirs of the Travaux du Cabinet de Géographie Physique de l'Université de St. Pétersbourg (partly out of print) concerning (1) Temperature and Precipitation of Eastern Siberia, by Ivitskii; summer rains predominate everywhere, except on Kamtshatka, Sea of Okhotsk and Sakhalin; (2 and 3) Climate and Winds of Batum, by Moskalskij and Novitskij; humidity very high, land winds like foehns; (4) Climates of the Heights of Western Europe, by A. Voeikov; (5) Intensity of Solar Radiations at St. Petersburg and the Pavlovsk Observatory, 30 km. S. of Petersburg, by W. Chipchinskij; observations taken with instruments of Chwolson and of Chwolson-Ångström, absolute maxima generally falling in the forenoon. H. B.

1249. *Numbers of Star Images on Oxford Astrographic Plates.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 68. pp. 397–414, March, 1908.)—Various investigations have been made by other observers to determine, by actual counting, the star-density on various portions of the plates taken for the Astrographic Catalogue. The differences in the numbers found may be due to several causes besides actual differences of star aggregation, and some of these are investigated, as tilt of plate to axis of objective, change of focal length, atmospheric absorption, &c. C. P. B.

## LIGHT.

**1250.** *New Form of the König Spectral Photometer; Application to Determination of Chemical Equilibria.* **J. Hildebrand.** (Zeitschr. Elektrochem. 14. pp. 349–353, June 26, 1908. From the Physikal.-chem. Inst. d. Univ., Berlin.)—The author shows that the König spectral photometer can be modified so as to be used with two light-sources of equal power, which are obtained by the use of two incandescent electric lamps. The standard source of light was a tungsten lamp. The apparatus can be used for spectrophotometric measurements in different regions of the spectrum, and the author has tested it with solutions of copper and cobalt sulphates. He has also by its means determined the dissociation constant of phenolphthalein and found it to be $1{\cdot}7 \times 10^{-10}$. A. F.

**1251.** *Zonal Errors of Reflecting Telescope.* **A. C. Lunn.** (Astrophys. Journ. 27. pp. 280–285, May, 1908.)—An analysis of the possibility of correcting the zonal errors of magnification in reflectors by combining the individual errors of units. It is concluded that in any system or optical combination consisting of a central system of reflecting surfaces of revolution, each of which is individually corrected for axial aberration, the relative zonal errors of magnification at given points in the final angular aperture are identical with those of a single mirror giving the same paraxial magnification. In the astronomical case with the object under view at infinity, the eccentricity of the first mirror is unity. The advantage of the Gregorian, and more especially of the Cassegrainian form of telescope over the Newtonian lies in the increased focal length and consequently diminished relative aperture attainable. C. P. B.

**1252.** *Effect of a Prism on Newton's Rings.* **Rayleigh.** (Phil. Mag. 15. pp. 345–351, March, 1908.)—Records some observations of the effect described by Newton in his "Opticks," and puts the theory into a slightly different form from that put forward in the author's "Scientific Papers" (3. p. 318). The surfaces are treated as cylindrical. The effects predicted are observed with an optical "flat" and a prism of theoretically infinitesimal but practically perceptible curvature. The best results as regards achromatism would be obtained with a grating of not more than 3,000 lines to the inch. E. E. F.

**1253.** *Secondary Waves of Light.* **C. V. Raman.** (Nature, 78. p. 55, May 21, 1908.)—It has been held hitherto that, so long as the diffraction apertures used (cut in perfectly opaque or perfectly reflecting screens) are large compared with the wave-length of light, Fresnel's expression for the amplitude of the disturbance due to a surface-element gives us a close approximation to the observed diffraction-effects, and that the exact value of the obliquity factor is of little importance. Some new diffraction phenomena studied by the author show that the above is true only in the special case in which the apertures are held normal to the waves of light. The theoretical grounds on which the experiments were based are : If diffraction bands are produced and observed in a direction in which the amplitude of the disturbance in the secondary waves varies rapidly from point to point, we might expect effects due to varying obliquity. If the image of the slit of a spectrometer is observed by very oblique reflection from the surface of a prism, then from the ordinary theory it would be expected that the maxima of illumination in corresponding bands on either side of the middle one should be of equal brightness. This is not the case; it is found that the bands on one side are considerably fainter than those on the other, and this difference becomes very large as the light approaches grazing incidence. The illumination in the diffraction pattern (with a given angle of incidence) decreases as we approach the limiting plane of the fringes, which is the plane of the reflecting surface. The effect is explicable if the question of the variation of the amplitude in different directions of the secondary waves is not taken into account. A fuller discussion and mathematical investigation will be published. A. W.

1254. *Theory of Dispersion.* **L. Mandelstam, M. Planck.** (Phys. Zeitschr. 9. pp. 308–311, May 1, and p. 354, June 1, 1908.)—Further support for Mandelstam's contention [see Abstracts Nos. 1309, 1345 (1907)] that the usual electro-magnetic model of dispersion produces no extinction attributable to the resonators dissipating energy by radiation. The vibrating electron exerts that portion of the force which governs its own damping, not only upon itself, but upon every charge situated within a distance small compared with the wave-length. E. E. F.

1255. *Refraction and Dispersion of Helium.* **K. Herrmann.** (Deutsch. Phys. Gesell., Verh. 10. 5. pp. 211–216, March 15, 1908. Physikal. Inst., Halle, Feb. 26, 1908.)—Using the method of Travers, the author obtains a perceptible dispersion of helium, the refractive index varying from 1·000034884 at $\lambda = 579$ $\mu\mu$ to 1·000035335 at $\lambda = 436$ $\mu\mu$. [See, however, next Abstract.] E. E. F.

1256. *Refraction of Helium.* **K. Scheel** and **R. Schmidt.** (Deutsch. Phys. Gesell., Verh. 10. 5. pp. 207–210, March 15, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—According to Rayleigh, the refraction of helium for the sodium line is 1·0000427, and according to Ramsay and Travers, 1·0000362. The authors, using an interference method, obtain 1·0000340 for the whole visible spectrum, and conclude that the dispersion of helium is zero. E. E. F.

1257. *Photographic Action of Infra-red Rays.* **A. G. de Moncetz.** (Comptes Rendus, 146. pp. 1022–1024, May 18, 1908.)—When blue light or Röntgen rays are used for fogging a plate, the fog is destroyed by infra-red rays extending from 800 to 1,000 $\mu\mu$. When Röntgen rays alone are used, there is a region, comprised between 920 and 1,350 $\mu\mu$, where the fog is increased instead of being destroyed. This indicates a method of photographing this region. No effect is obtained if the plates are not fogged, or if they are fogged by ordinary light. E. E. F.

1258. *Electrochemistry of Light.* I. and II. **W. D. Bancroft.** (Journ. Phys. Chem. 12. pp. 209–278, April, and pp. 318–376, May, 1908.)—A discursive paper in which the following general conclusions are drawn concerning the chemical action of light. Only those rays which are absorbed can produce chemical action, the action of a ray of light being analogous to that of a voltaic cell. But even with light-sensitive substances, all of the absorbed rays are not necessarily active. The presence of a depolariser increases or renders possible the action of light and the oxidisability or reducibility of any given substance depends on the depolariser. When two substances react under the influence of light, a determination of the active rays will usually show which substance has been made active by light and which is to be regarded as the depolariser. In many cases of oxidation by oxygen gas, the oxygen acts as a depolariser. When chlorine reacts with silver, or bromine with toluene, it is the halogen which is rendered active by light. The following further results have been obtained and are dealt with in the second part. The maximum of the absorption band for dyed silver bromide—which is the important factor—coincides with the maximum of the sensitising action for the same dye. Sensitisers are either direct or indirect polarisers and are light-sensitive, but the light-sensitiveness and the sensitising power do not necessarily run strictly parallel. Sensitisers either are reducing agents in the broad sense of the term or are rendered so by light. Light reduces cyanine and the eosine dyes, the latter losing halogen. Cyanine and eosine dyes are also converted into reducing agents by light. No connection exists between sensitising power and fluorescence. The electrochemical theory of light accounts for all the known facts in regard to sensitisers.

T. H. P.

**1259.** *Metallic Arcs for Spectroscopic Investigations.* **A. H. Pfund.** (Astrophys. Journ. 27. pp. 296–298, May, 1908.)—A simple form of adjustable arc pole is described, which is stated to eliminate many of the difficulties met with owing to the irregular burning usually found. A lower positive electrode of iron is used, and an upper negative one of carbon. On the lower is placed a small bead of the metal whose spectrum is required, and then if the current is suitably adjusted the arc will burn steadily for an hour or more. [Abstract No. 242 (1908).]

C. P. B.

**1260.** *Spectrum of Oxygen* (*Doppler-effect in Canal Rays*). **J. Stark.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 28. pp. 554–577, 1908.)—Using a spectroscope with great power of illumination and high resolving power, the author has examined the spectrum of the canal rays in oxygen with considerable care. The lines of the spark spectrum are strong in the canal rays, and the displaced line is also well marked; it has an intensity about twice as great as that of the undisplaced line, and from the amount of displacement the author concludes that the emitter of the spark lines is a trivalent positive oxygen ion. In the case of the series lines $\lambda 4778$, $\lambda 4868$, and $\lambda 3947$ the intensity is less than in the previous case, and the displaced line is so feeble that exact measurement is impossible, the ratio of the intensity to that of the undisplaced line being 1/15. The positive and negative band-spectra are also examined, and the Doppler-effect for two Al lines is also observed. A table giving a summary of the work of different experimenters on the Doppler-effect in the canal rays for various substances is given, and as a result the author reaffirms the law previously given [see Abstracts Nos. 57 and 640 (1907)], that the emitter of the line spectrum is the positive atom-ion, and that the emitter of the doublet series is a monovalent ion, and of the triplet series a di-valent ion. He also suggests that the atoms may have a greater number of different valencies than can be recognised by their chemical effects, and that the electrons which by their displacement give rise to chemical affinity may be near the surface of the atom, while those which by their rotation give rise to light-waves lienearer the centre.

S. G. S.

**1261.** *Distribution of Intensity of Emission by Canal Rays in Hydrogen.* **J. Stark** and **W. Steubing.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 28. pp. 578–585, 1908.)—According to F. Paschen [Abstract No. 1848 (1907)] the intensity of emission by an atom is independent of its velocity, while on the other hand J. Stark maintains that this is not the case [see Abstracts Nos. 57 and 1820 (1907)]. The authors have attempted to settle the question by observing the relative intensity of three lines for different kathode p.d.'s, and hence different velocities of the ions, the Doppler-effect being excluded by receiving the light in a direction at right angles to the canal rays. If the distribution of intensity is independent of the velocity it must also be independent of the kathode p.d. The results show that the increase in intensity of emission as the kathode p.d. rises is much more rapid for the more refrangible rays than for the less refrangible, thus bearing out Stark's conclusion. S. G. S.

**1262.** *Mechanical Phosphorescence.* **A. Stephenson.** (Phil. Mag. 15. pp. 352–363, March, 1908.)—The phenomena of phosphorescence may be very closely imitated by a mechanical model. The author describes the principle as follows: "Consider a particle suspended from a fixed point by a light elastic string; if we regard the system as confined to a vertical plane it is fixed by two co-ordinates, and the normal motions are the vertical vibration and the horizontal (pendulum) swing. If the system is frictionless—a case which may be considered by way of introduction—the normal motions are in general practically independent; the vertical vibration creates a small periodic change in the spring of the pendulum motion, while the latter exerts a second order forcing disturbance on the former, but neither of these actions is cumulative in effect unless the periods are properly adjusted. When the periods vertically and horizontally are approximately in the ratio 1/2 there is mutual interaction: if the system is initially in vertical motion, any small horizontal swing is gradually magnified through the periodic change of approximately double frequency in its spring; while if, on the other hand, the motion is initially horizontal, a vertical vibration is forced by the isochronous variation in the tension. Now let us suppose that the vertical co-ordinate is subject to kinetic friction, while the other is frictionless. Then, whatever the relation between the periods, the pendulum motion forces a small oscillation vertically, in general of second order amplitude, maintaining it against friction; thus the energy is gradually dissipated and the frequency of the emission is double that of the pendulum. Consider the effect of a periodic disturbance applied radially. In general it will merely produce an isochronous forced vibration vertically, but if the frequency is approximately double that of the pendulum motion, this oscillation will in turn magnify any existing small pendulum swing; thus the system stores energy absorbed from incident disturbance of the particular frequency. For a given intensity of disturbance the amount of energy obtained in this way will depend upon the time of action, but evidently it must have some definite upper limit. When the exciting force is removed the pendulum motion generates a comparatively small forced oscillation vertically of double its own frequency, which continues until the energy is dissipated against the kinetic friction. Thus the system gives out the stored energy in a definite frequency during an interval which is comparable with, and may indeed be large compared with, the time of action of the incident disturbance. That is, the system phosphoresces." The author works this out mathematically and quantitatively, and shows that all observed phosphorescence effects are paralleled except phosphorescent hysteresis. E. E. F.

1263. *Triboluminescence of Mineral Substances.* **A. Karl.** (Comptes Rendus, 146. pp. 1104–1106, May 25, 1908.)—Triboluminescence is a fairly general property of solids, in many of which, such as thorium oxide, titanic and tungstic acids, zirconia and cadmium sulphide, it is only observed after the eye has become accustomed to the darkness. Resistance to crushing may also prevent triboluminescence from being observed, as also may excessive fragility, which may be obviated by plunging the substance in liquid air. The phenomenon of triboluminescence is not exhibited by pure substances, but requires the co-existence of large proportions of a diluent and a small amount of a triboluminogen, a certain quantity of which produces a maximum result. A triboluminescent system mostly, but not always, retains its property when subjected to chemical changes. The colour of the light emitted varies with the triboluminogen and with the diluent, and, further, is not necessarily the same as in the phosphorescence of the same mixtures.
T. H. P.

1264. *Life of Radium.* **B. B. Boltwood.** (Amer. Journ. Sci. 25. pp. 493–506, June, 1908. Contribution from the Sloane Phys. Lab. of Yale Univ.)—The early part of the paper gives a convenient summary of the methods that have been used to fix the half-value period of radium. The later part gives a new method of determining this constant independently of the purity of all standards, and hence resting on the smallest amount of assumption. If the amount of radium in a mineral in equilibrium with its parent substance, ionium, be determined, $I_0$ say, and the amount $dI$ produced in unit time, one year, by this same quantity of ionium be also found then the constant $\lambda$ of radio-active change is the ratio $dI/I_0$. Both $dI$ and $I_0$ are found by measuring the leak produced in an electroscope by the emanation boiled off from a solution of the mineral. A solution of the mineral is made, and the emanation from a definite quantity is measured; this gives $I_0$. The ionium is then separated from radium, and the quantity of the latter produced in a known time is also determined by the emanation method. Correction is made for the decay of the emanation in the period between successive tests. The final result shows that the half-value period of radium is 2,000 years.
R. S. W.

1265. *Meso-thorium.* **O. Hahn.** (Phys. Zeitschr. 9. pp. 392–404, June 15, 1908. Chem. Inst. d. Univ., Berlin, May 9, 1908.)—The existence of mesothorium—intermediate to thorium and radiothorium—is now well established [see Abstracts Nos. 1009, 1647, 1887 (1907), and 1098 (1908)]. McCoy has found independently that mesothorium gives no $\alpha$-rays; he also gives the period as 5·5 years, whereas that of radiothorium is 737 days. In the present paper further results are given of the author's experiments. From observations of the activity of old samples of thorium salts recovery-curves were obtained, and McCoy's results for the transformation period of mesothorium were confirmed. It was also found that mesothorium freed from radiothorium regained its $\alpha$-activity in 1·5 years. The fact that mesothorium gives out only $\beta$-rays and no $\alpha$-particles received further confirmation.
A. W.

1266. *Distribution of Rays near Radio-active Bodies.* **H. Greinacher.** (Phys. Zeitschr. 9. pp. 385–392, June 15, 1908. Physikal. Inst. d. Univ., Zürich, May, 1908.)—When a piece of a uranium compound is placed on a photographic plate, a marked blackening takes place opposite all faces of the body, but near the corners very little blackening occurs. It seems as if very feebly photographic rays proceeded from the angle. The effect is more marked for small angles than for large ones, and of course vanishes altogether for an angle of 180°. The author has investigated this phenomenon, and finds that it is due to secondary radiation from the $\beta$- and $\gamma$-rays. A. W.

**1267.** *Range of a-Rays.* **W. Duane.** (Comptes Rendus, 146. pp. 958–960, May 11, 1908.)—The ionising, luminescent, and photographic actions of $\alpha$-rays cease after the rays have traversed a few cm. in air. The author proves, in addition, that the rays lose their positive charge within the same range [see next Abstract]. E. E. F.

**1268.** *Secondary Rays from a-Rays.* **W. Duane.** (Comptes Rendus, 146. pp. 1088–1090, May 25, 1908.)—In a previous note [see preceding Abstract] the author has shown that the charge of the $\alpha$-rays disappears abruptly at the same distance from the active substance as the ionising, photographic and phosphorescent actions. He now shows that the rays cease to produce secondary radiation at the same distance. The $\alpha$-rays pass through a mica sheet into an exhausted vessel, where they fall on a metal plate parallel to the mica. If $a$ is the charge carried to the plate by the rays, $s_1$ the negative charge carried away by the secondary rays, $s_2$ the negative charge carried to the plate by the secondary rays produced on the mica, then the total charge going to the plate is $a + s_1 - s_2$. Of these $s_2$ can be stopped by an electric field between the plate and the mica, and $s_1 + s_2$ by a strong magnetic field. The difference of the currents in these two cases is then $s_1$. It is found that $s_1$ ceases when the radium is 2 cm. from the mica, and this is the distance at which the charge has been found to disappear. R. S. W.

**1269.** *Radio-active Emanation in the Soil.* **A. Gockel.** (Phys. Zeitschr. 9. pp. 304–306, May 1, 1908.)—Confirms in the main the conclusions arrived at by Brandes with regard to the dependence of emanation upon barometric pressure. But the permeability of the soil is of greater determining power than barometric pressure. Rain produces an increase of emanation in the air. Gusty weather is particularly effective in this direction. But the maximum content of emanation is found when the soil is frozen hard, and then the emanation is also most concentrated in the soil itself. Explanation appears difficult. E. E. F.

## REFERENCES.

**1270.** *Simple Reflection Goniometer.* **A. F. Rogers.** (Science, 27. pp. 929–930, June 12, 1908.)—To encourage the study of crystals the writer describes how to make a simple goniometer at small expense which will measure, by the motion of a pointer on a protractor, the angles of small crystals with bright faces to quarter of a degree. G. E. A.

**1271.** *Dispersion of Rock Salt.* **W. J. H. Moll.** (Archives Néerlandaises, 13. 1. and 2. pp. 135–142, 1908.)—Compares the constants, formulæ, and observations of Langley, Rubens, and Martens. E. E. F.

**1272.** *Optical Properties of Colloidal Gold-solution.* **W. Steubing.** (Ann. d. Physik, 26. 7. pp. 329–371, June 9, 1908.)—The solutions used in the experiments described in this paper were similar, and prepared by methods similar to those of Siedentopf and Zsigmondy [Abstract No. 1169 (1903)]. The properties dealt with were (i.) absorption, (ii.) transmission and reflection, (iii.) polarisation. The results obtained are given in numerous tables and diagrams, for which see original paper. A. W.

## HEAT.

**1273.** *Electric Calorimeter.* **H. T. Barnes.** (Science, 27. pp. 790–791, May 15, 1908.)—Describes a simple form of continuous-flow calorimeter for determining Joule's equivalent. A glass tube, about 50 cm. long and 2 to 3 mm. internal diam., is cemented at both ends to brass collars carrying washers and nuts, which screw into brass castings drilled out to receive suitable thermometers. A heating wire, of about 10 ohms, coiled in a long helix, passes through the tube and is soldered to the brass collars. The helix serves to break up the stream-lines, and thoroughly mix the water as it flows through. A copper or tin vessel with overflow maintains a constant head of water at any desired elevation, and a tube conveys the water to the inflow end of the calorimeter. An air trap, made from an inverted thistle tube, serves to catch any air-bubbles liberated or carried down by the water. The temperature of the inflowing water is measured on the thermometer. After passing through the tube, the water is collected at the outflow end in a suitable measuring vessel. The temperature of the outflowing water is recorded at regular intervals (after the steady state has been reached) on the second thermometer. The upper end of the brass T-piece, to which the outflow pipe is attached, is open to the air and establishes the head independently of the exact level of the end of the outflow pipe. Readings are taken at regular intervals on a tangent galvanometer or a Weston ammeter of the current in the heating coil, the potential drop at the ends being also noted. Readings of the inflow and outflow temperatures during the time taken to obtain a suitable amount of water to weigh, enable the heat developed to be calculated, and the ratio of the electrical energy in watt-seconds to this amount gives the value of J. The radiation correction is very small if the mean temperature of the water is not more than about 5° C. different from the room temperature. A suitable current through the heating coil is 2 to 4 amps.; this, with a waterflow of 2 to 4 gm. per sec. gives a temperature-rise of from 6 to 12°.

A. W.

**1274.** *Mechanical Equivalent of Heat.* **L. Kann.** (Phys. Zeitschr. 9. pp. 263–264, April 15, 1908.)—Describes a simple apparatus which is at the same time the receptacle of mechanical energy, the calorimeter and the thermometer required for determining the mechanical equivalent of heat. Two large glass bulbs are connected by a capillary. One of them is filled with mercury, which penetrates half-way into the capillary. The rest is a vacuum. The work is done by reversing the bulbs a number of times, so that the mercury flows from one into the other. The work done at every reversal is that of raising the mercury against gravity through the space dividing the centres of the two bulbs. The work is converted into that of heating the mercury and glass, and the mercury acts as its own thermometer and the capillary may be graduated in degrees. The dimensions must be such that the thermometer readings are as large as possible, but that the flow does not take too long. The mass of mercury should also considerably exceed the mass of the glass.

E. E. F.

**1275.** *Isotherms of Helium at —253° and —259°.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 741–742,

April 24, 1908. Communication No. 102*c* from the Phys. Lab., Leiden.)—The author has determined several points on the isotherms of helium for —252·72° and —258·82°. The values for $pv_A$ when $d=o$ are 0·07455 at —252·72° and 0·05222 at —258·82°. The number of points on the isotherms is too small and the densities are too large to give the first individual virial coefficients of the equation of condition. Graphic representation shows, however, that the isotherm $pv_A$ for —259° must exhibit a minimum, and hence $B_A$ must be negative at this temperature. Also the intersection of the isotherm for —253° with the axis $d=o$ lies near the Boyle point, and $B_A$ is probably only slightly negative at this temperature. These results are in good agreement with those previously obtained [Abstract No. 948 (1908)].
T. H. P.

## REFERENCES.

1276. *Variation of Specific Heat of Platinum and Nickel.* **W. Schlett.** (Ann. d. Physik, 26. 1. pp. 201–210, May 12, 1908. Extract from Inaug.-Dissertation, Marburg, July 22, 1907.)—Discusses variations in physical properties of metals as the result of different mechanical work, and shows that the specific heats of Pt and Ni are lower as the specific gravities are increased by drawing, &c., in accordance with Richarz's law. [See Abstracts Nos. 1843 (1905) and 1081 (1907).] C. O. B.

1277. *Linear Expansion of Ebonite Rods.* **R. Wagner.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 905–928, May, 1907. From the math.-physikal. Kabinett d. Univ., Graz.)—The dependence of the expansion on the tension applied is investigated by observation of the temperature-changes produced when the rods are bent.
L. H. W.

## SOUND.

**1278.** *Laws of Vibration of the Tuning-fork.* **A. Stefanini** and **G. Gradenigo.** (N. Cimento, 15. pp. 181–176, Feb.-March, 1908.)—The tuning forks are excited by distending them with threads weighted by a mass which is cut off to start the vibration. The time after which the sound becomes inaudible is determined for different weights. The logarithmic decrement is determinable from two such observations. The first vibration has an amplitude considerably below double the initial static displacement. The logarithmic decrements of various forks are approximately the same within the ordinary range of musical notes [see Abstract No. 1874 (1907)]. E. E. F.

**1279.** *Photography of Speech.* **Devaux-Charbonnel.** (Comptes Rendus, 146. pp. 1258–1260, June 15, 1908.)—The author points out various advantages in the use of the microphone and oscillograph for the purpose of the photography of speech vibrations. He has carried out this method for six French vowels, and the analysis of the curves thus obtained yields the results tabulated below. The numbers in the table give the amplitudes in the upper line for each vowel and the phases in the lower line.

| Number of Partials. | 1. | 2. | 3. | 4. | 5. | 6. | 8. | 9. | 12. | 13. |
|---|---|---|---|---|---|---|---|---|---|---|
| Vowels. | | | | | | | | | | |
| A | 1·0 | 1·7 | — | 3·0 | — | 4·8 | — | — | — | — |
| | 0 | +90 | | +90 | | −90 | | | | |
| O | 1·0 | — | 2·4 | — | 4·2 | — | — | — | — | — |
| | 0 | | 0 | | +180 | | | | | |
| E muet | 1·0 | — | 1·5 | — | — | — | 2·0 | — | — | — |
| | 0 | | −80 | | | | +180 | | | |
| É accentué | 1·0 | 5·5 | — | — | — | — | — | — | 6·0 | — |
| | 0 | −180 | | | | | | | −90 | |
| U | 1·0 | 2·0 | — | — | — | — | — | 1·5 | — | — |
| | 0 | +90 | | | | | | +90 | | |
| I | 1·0 | 4·2 | — | — | — | — | — | — | — | 2·8 |
| | 0 | 0 | | | | | | | | +90 |

E. H. B.

**1280.** *Sound Speeds in Air up to 200 Atmospheres' Pressure.* **P. P. Koch.** (K. Bayer. Akad. München, 28. Ber., 1907. Ann. d. Physik, 26. 3. pp. 551–579, July 7, 1908. Abstract.)—Witkowski had tested the speed of sound in air up to pressures of 100 atmos. and at temperatures of 0° C. and about −79°. The present author using about the same temperatures has extended the range of pressures to about twice the value. He used the double form of Kundt's tube apparatus, the sounding rod being of steel. The air under test was dry and free from $CO_2$. His chief results are shown in the following table :—

| Pressures in Atmos. | Ratios of Sound Speeds in Experimental Tube and Standard Tube. | |
|---|---|---|
| | At 0° C. | At −79°·3 C. |
| 1 | 1·000 | 0·842 |
| 25 | 1·008 | 0·831 |
| 50 | 1·022 | 0·830 |
| 75 | 1·041 | 0·843 |
| 100 | 1·064 | 0·885 |
| 125 | 1·095 | 0·960 |
| 150 | 1·132 | 1·047 |
| 175 | 1·173 | 1·140 |
| 200 | 1·220 | 1·239 |

E. H. B.

1281. *Geometrical Representation of the Gamut.* **R. Chassériaud.** (Journ. de Physique, 7. pp. 387–397, May, 1908.)—The seven notes of the diatonic scale are here represented by points on a circle. Thus, likening the circle to the dial of a clock, *do* is put at VI, *re* midway between VI and IX, *mi* at IX, *fa* at X, *sol* at XII, *la* at II, *si* midway between III and VI. Then each chord is characterised by points which form a particular triangle, usually isosceles and sometimes right-angled or equilateral. The exact relations of the notes in just intonation is discussed, also the provision for sharps and flats, and, towards the close of the paper, a few bars of one of Beethoven's sonatas for the piano is represented on this notation by triangles, quadrilaterals, &c. E. H. B.

1282. *Melody and Origin of Musical Scale.* **W. C. Sabine.** (Science, 27. pp. 841–847, May 29, 1908.)—On the view of Helmholtz the basis of melody is purely that of rhythm, and rhythm based on a scale of intervals. The scale of intervals in turn is based on a recognition, conscious or subconscious, of the compound character of musical tones and of the existence, in tones of different pitch, of partials of the same pitch. This, the present author objects, calls for a degree of musical insight and discrimination which it is difficult to credit to a primitive art. It is in reality, he considers, the skill of the highly trained musician, of a musician trained by long experience with sounds which are rich and accurate in quality. This power of analysis, it is here thought, goes with supreme skill rather than with the early gropings of an art. The following modification of the theory of Helmholtz is then put forward. Though melody is written as a pure succession of discrete notes, one beginning only when the other has ceased, and it is so produced on homophonic instruments such as the flute or voice, it is *not necessarily so heard.* A sound produced in a space which is in any way confined continues until it is diminished by transmission through openings, or is absorbed by the retaining walls or contained material to such a point that it is past the threshold of audibility ; and this prolongation of audibility of sound is under many conditions a factor of no inconsiderable importance. In many rooms of ordinary construction the prolongation of audibility amounts to 2 or 3 seconds. As a result of this, single-part music produced as successive sounds is nevertheless heard as overlapping tones. Each note may well be audible with appreciable intensity not merely through the next note, but through several succeeding notes. Under such conditions we have every opportunity even with single-part music for the production of all the phenomena of harmony and discord which have been discussed by Helmholtz in explanation of the chordal use of the musical scale. In any ordinarily bare and uncarpeted room one may sing in succession a series of notes, and then hear for some time afterward their full chordal effect. All the arguments that Helmholtz advanced in support of his hypothesis that the musical scale was devised solely from considerations of rhythm and founded on a repetition of faint upper partials, hold with equal force in the explanation here proposed. The identity of partial tones in compound tones with different fundamentals is one of the conditions of harmony, and the scale devised by consideration of the mutual harmony of the notes sounded simultaneously would, in every respect, be the same as that of a scale based on repeated upper partials. In the one case the identity of upper partials is an act of memory (Helmholtz's view); in the other it is determined by the harmony of sustained tones (Sabine's hypothesis). All the arguments by Helmholtz based on historical considerations and on racial and national differences are equally applicable to the hypothesis of sustained tones. In fact, they take on an additional significance, for we may now view all these differences not merely in the light of differences in racial development and temperament, but in the light of physical environment. Housed or unhoused, dwelling in reed huts or in tents, in houses of wood or stone, in houses and temples high-vaulted or low-roofed, of heavy furnishing or light, in all these conditions the author looks for the factors which determine the development of a musical scale in any race, the rapidity of the growth of the scale, its richness and its considerable use in single-part melody. The author thus, not merely with Helmholtz, regards melody as rhythm in time and pitch, but also as harmony in sustained tones, and sees in the history of music—certainly in its early stages, but possibly also in its subsequent development—not only genius and invention, but also the effect of physical environment. [See also Abstracts Nos. 1087 and 1740 (1906.] E. H. B.

## ELECTRICITY AND MAGNETISM.

### THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1283. *Registration of Earth Currents at Batavia.* **W. van Bemmelen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 782–789, May 26, 1908.)—In a previous paper [Abstract No. 854 (1908)] it has been shown that the earth current between Anjer and Batavia is 4 times greater than the one between Batavia and Cheribon. Extended observations showed clearly that the current between Semarang—Soerabaja and Semarang—Cheribon corresponds in character and intensity to that between Batavia—Cheribon. The conclusion is that the oscillations of both short and long duration of magnetic force at Batavia and at Buitenzoog have the same ratio of amplitude, and that they therefore cannot be caused (or only for a small part) by the current running through the outer crust of the earth. C. P. B.

### DISCHARGE AND OSCILLATIONS.

1284. *Photo-electric Canal-rays.* **H. Dember.** (Ann. d. Physik, 26. 7. pp. 403–408, June 9, 1908.)—Observations were made on the discharge from sensitive zinc and magnesium plates in a vacuum tube. From the experiments it appears that with the direct photo-electric effect, as well as in the case of the discharge in Geissler tubes, there takes place at the same time along with the kathode rays a *positive* current of charged particles in the opposite direction. J. J. S.

1285. *Effect of Hydrogen on the Discharge of Negative Electricity from Hot Platinum.* **H. A. Wilson.** (Roy. Soc., Phil. Trans. Ser. A. 208. pp. 247–278, May 26, 1908. Proc., Ser. A. 80. pp. 379–382, May 25, 1908. Abstract.)—It is known that the negative leak can be represented by the formula $x = A\theta^{\frac{1}{2}}e^{-Q/2\theta}$, where $x$ = leak, $\theta$ = absolute temperature, and A and Q are constants. The author shows that in hydrogen Q and A depend on the pressure, and that this variation can be deduced from the assumption that $x = Bp^n$, where $p$ = pressure of hydrogen, and B and $n$ depend on the temperature only, $n$ being less than unity. The results obtained with a new wire and with one that has been heated in hydrogen for a considerable time differ greatly. With the former the leak rises with the pressure and falls when it is reduced. If an old wire, which is giving a leak independent of pressure, is heated in air the leak is greatly reduced. If, now, hydrogen is admitted, the leak at high temperatures is not affected at first, but finally develops rather quickly; it then rises with pressure, and has about the same value as a new wire. On reducing the pressure the leak falls very slowly with time. When the leak is independent of the pressure the author concludes that it is then due to hydrogen combined with the platinum of the surface layer, and that this compound has a dissociation pressure less than 0·002 mm. even at temperatures as high as 1,600° C. Absorbed hydrogen is known to increase the electrical resistance of platinum; it is found that leak and resistance at 0° decrease at the same time. The negative leak is found to be enormously increased by passing a luminous discharge from the wire to an outer electrode. Various analogies between the negative leak in hydrogen and the positive leak in oxygen are pointed out. The conclusions finally reached are that the effect of the hydrogen on the negative leak is due to its presence in the surface layer. To explain this an electrical double layer is supposed, and the hydrogen atoms, being positively charged, diminish the charge of this layer. The gas appears to dissolve in the Pt at first, but at high pressures in time forms a stable combination. R. S. W.

**1286.** *Gases from Electric Sparks.* **M. de Broglie.** (Comptes Rendus, 146. pp. 624–625, March 23, 1908.)—The air coming from "condensed" sparks contains ions of feeble mobility (10 microns per sec.), neutral centres which are easily ionised, and a light dust which shows Brownian movements. The latter is most abundant in the case of Na, Tl, and Bi. The sodium dust is quickly transformed into droplets when the air is moist. Bubbled through water, the gases give no visible cloud in the beam of an arc light, but they do when the water contains traces of salts. E. E. F.

**1287.** *Ultramicroscopic Examination of Ionised Gases.* **de Broglie.** (Comptes Rendus, 146. pp. 1010–1011, May 18, 1908.)—Ionised gases may be examined ultramicroscopically by placing them between two glass plates surrounded by an insulating liquid such as vaseline oil. Thermal convection is thus avoided, and a p.d. of about 100 volts may be applied. In the ultramicroscope some of the suspended particles are then seen to travel with the field, others against it, and a third variety remain motionless unless further ionised by Röntgen rays or some other ioniser. E. E. F.

**1288.** *Recombination of Ions in Dielectrics.* **P. Langevin.** (Comptes Rendus, 146. pp. 1011–1013, May 18, 1908.)—The equation $\epsilon = \alpha/4\pi(k_1 + k_2) \leqq 1$ for the rate of recombination $\alpha$ and the mobilities $k$, already established for gases [see Abstract No. 1708 (1902)] may be applied to solid and liquid dielectrics by multiplying by K, the dielectric constant. The author indicates a method of determining $\epsilon$ experimentally in dielectrics, and announces that, in spite of the almost incomparably smaller mobilities, the ratio $\epsilon$ as determined in solids remains sensibly near unity. E. E. F.

**1289.** *Discharging Action of Sodium.* **C. E. S. Phillips.** (Nature, 78. p. 79, May 28, and p. 127, June 11, 1908.)—A freshly cut piece of sodium rapidly discharges an electroscope when the latter is negatively charged. The action is stopped by interposing a membrane of celluloid sufficiently thin to give interference colours, or a soap film, and also by blowing an air current past the surface, or heating the metal to its melting-point. Potassium gives no similar effect. The surface glows strongly in the dark. No active gas can be driven from the sodium by heat, and the true explanation of the action lies in the positive electrification of the air surrounding the freshly cut surface. When the metal is heated the action is violent, but it quickly falls away owing to the oxidation of the metal. E. E. F.

**1290.** *Conductivity of Explosive Flames with Different Electrodes.* **De Muynck.** (Annal. Soc. Sci. de Bruxelles, 32. 2. pp. 126–131, 1907–1908.)—The author fixes two blade electrodes 0·8 cm. apart in a tube of brass, 24 cm.

long, 19 cm. in diam., joins the electrodes to a d'Arsonval galvanometer, and watches the currents which flow at the moment when the mixture of carbon monoxide and oxygen under a pressure of 878 mm. explodes. With two electrodes of the same metal the currents are very feeble. With electrodes of different metals the currents are stronger, but decrease when several explosions follow one another. The current direction is from Cu through the galvanometer to Al, and the order of the metals is Zn, Pb, Al, brass, Fe, Cu; the latter two did not give concordant results. The currents become stronger again at once when the metal is rubbed with emery, and recover slowly after several days of rest. When the electrodes are joined to a battery to obtain a p.d. of about 100 volts the currents are much stronger, and they flow more easily in one direction than in the other; this unipolarity cannot be ascribed to the just-mentioned p.d. between the metals. It is pointed out that the series as stated is practically the voltaic series (the Al is not in its right place), and that the order does not agree with radio-activity, nor with the kathode fall of potential in hydrogen. Reference is made to Willaert's experiments with metallic electrodes in gases. [Compare Abstract No. 1921 (1907).] H. B.

**1291.** *The Spark of Self-induction.* **A. Léauté.** (Comptes Rendus, 146. pp. 1209–1211, June 9, 1908.)—Hemsalech when examining by a photographic method the spark produced on inserting a gap in a circuit round which there passed the current of discharge from a condenser across a self-induction, noticed in each oscillation of the same spark a certain number of striæ equally distant the one from the other [Abstracts Nos. 1075 (1907) and 1140 (1908)]. Battelli and Magri have recently contested the equi-distance of these striæ [Abstract No. 1671 (1907)], and have attributed them to irregular expulsions of metallic vapour proceeding from the electrodes. The author has investigated the cause of the striæ, and finds that the coil with self-induction intercalated in the discharge circuit alone plays a part in the production of the phenomenon. Hemsalech employed a long coil with two layers of wire. When the author used a flat coil with 25 superposed layers the striæ were not seen, but they appeared when a condenser was placed in a derived circuit between the terminals of the coil. Experiment seemed to show that the existence of the striæ in the oscillations was due to the capacity which two consecutive layers of a coil with self-induction present. In order that a coil should give rise to visible striæ it was found that it was sufficient (1) that it should possess a high enough self-induction, and (2) that at one of its ends there should exist a great p.d. between two consecutive layers of wire. The essential cause of the striæ observed by Hemsalech is then the existence of two circuits in parallel that the discharge current from the condenser can traverse, and of which one contains the coil with self-induction, whilst the other closes itself near one of the extremities of this coil by an effect of capacity. J. J. S.

**1292.** *Stability of the Alternating-current Arc.* **C. E. Guye** and **A. Bron.** (Comptes Rendus, 147. pp. 49–51, July 6, 1908.)—In a preceding note [see Abstract No. 1188 (1908)] the authors emphasised the importance of the *rôle* played by the period of extinction of the arc between metals on the potential difference between the electrodes even when the arc is apparently burning steadily. This explains certain phenomena observed previously. In particular the results obtained by Guye and Monasch in 1908 are quoted. Unlike the experiments quoted in their recent paper (*loc. cit. ante*), the effects of the period of extinction were very noticeable. In the following table *d* is the distance between the electrodes and A the current in amps. :—

EFFECTIVE VOLTS.

| *d* in mm. | A in amps. | C. | Mg. | Fe. | Ni. | Cu. | Ag. | Cd. | Pt. | Au. |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 0·05 | — | — | — | 590 | 650 | 660 | 480 | 770 | 790 |
| 5 | 0·05 | — | — | — | 770 | 825 | 830 | 650 | 920 | 950 |
| 7 | 0·05 | — | — | — | 960 | 1,010 | 1,000 | 810 | 1,000 | — |
| 3 | 0·04 | — | 500 | 650 | 650 | 690 | 710 | 550 | 880 | 880 |
| 5 | 0·04 | 640 | 700 | 850 | 850 | 870 | 900 | 725 | 1,000 | 1,070 |
| 7 | 0·04 | — | 890 | 1,050 | 1,050 | 1,070 | 1,100 | 890 | 1,150 | 1,270 |
| 3 | 0·03 | — | 600 | 690 | 740 | 780 | 790 | 730 | — | 1,070 |
| 5 | 0·03 | — | 820 | 910 | 950 | 980 | 990 | 900 | — | 1,320 |
| 7 | 0·03 | — | 1,040 | 1,130 | 1,170 | 1,180 | 1,210 | 1,080 | — | — |
| Atomic weight... | | 12 | 24 | 56 | 59 | 63 | 108 | 111 | 194 | 197 |

We see that with the exception of cadmium, which emits heavy fumes, the p.d. between the electrodes increases rapidly with the atomic weight of the metal. We see, therefore, that in order that the arc may relight itself at each alternation it is necessary that the p.d. immediately preceding the lighting increase with the atomic weight of the metal. The explanation of this phenomenon seems to follow from the law of Dulong and Petit. The specific heat being inversely proportional to the atomic weight, it follows that the fall of temperature which occurs at the kathode at each extinction of the arc is greater the greater the atomic weight. It is not surprising, therefore, that the period of extinction between metals of high atomic weight is greater than between those of low atomic weight, and hence they require a higher applied voltage. In picturing also the mechanism of the arc we must admit that the electrons projected by the incandescent kathode, which are the necessary preliminary to the starting of the arc, must have a greater velocity, in order to ionise the adjacent metallic vapour, the greater the atomic weight. That velocity being rigorously determined by the p.d., the consequence is a longer period of extinction for arcs between metals of great atomic weight. It is also pointed out that the thermal conductivity of metals diminishes with temperature, and this effect complicates the phenomena. A. R.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

**1293.** *Variation of Resistance of Metals in a Magnetic Field.* **N. Dagostino.** (Accad. Lincei, Atti, 17. pp. 531–539, April 26, 1908.)—The author finds that iron and nickel exposed to a transversal magnetic field both decrease in resistance, such decrease increasing with the strength of field up to a certain limit (H = 6,000 about), above which no further decrease occurs. The metals Pt, Ag, Bi, Cd, Au, Zn, Mg, Pd, as well as invar and manganin, on the other hand, all *increase* in resistance in a transversal field ; but with the well-known exception of Bi only by roughly 1/10000 (except invar) for H = 6,000. With Fe and Ni the *decrease* is roughly 1/1000 and 1/100 respectively at this field strength. L. H. W.

**1294.** *Anomalous Behaviour of Selenium.* **C. Ries.** (Phys. Zeitschr. 9. pp. 228–233, April 1, 1908.)—The author distinguishes two forms of crystalline selenium, viz., $\alpha$ and $\beta$, and discusses the anomalous behaviour of selenium, as recorded by different observers, accordingly. Modification $\alpha$ has a negative temperature-coefficient of electrical resistance and is obtained by heating selenium at temperatures below 200° ; the transformation is most complete when prolonged heating at 195° is followed by rapid cooling. The $\beta$-modification has within certain limits a positive temperature coefficient, and is obtained by heating selenium at temperatures above 200°. The sensitiveness to light *diminishes* as the temperature to which the selenium is heated (for the formation of the $\beta$-modification) rises ; the sensitiveness to light of the $\alpha$-modification *increases* steadily as the temperature at which it is formed increases up to a limit of 195–200°, at which the transformation from the $\alpha$ to the $\beta$ modification begins. Light-sensitiveness and photo-electric properties are also considered in a separate article (ibid. pp. 164–169). D. H. J.

1295. *Current due to the Volta Effect, and Seat of the E.M.F. of Contact.* **O. M. Corbino.** (N. Cimento, 15. pp. 395–400, May, 1908. Istituto fisico d. R. Univ. di Messina. Phys. Zeitschr. 9. pp. 461–463, July 15, 1908.)—When an Al anode, coated with two films, the inner one having a thickness of about 0·002 micron, and the external one of about 0·02 micron, is immersed in a vessel containing mercury, the circuit being completed by a wire attached to the top of the anode and dipping into the mercury, a current passes through the wire, and a similar but opposite current also passes when the Al anode is withdrawn from the mercury. By employing an electrical device for immersing and withdrawing the anode 10 times per sec., and attaching a commutator, a current is produced of the order of 1/1000 amp., or 1,000,000 times greater than that obtained by Majorana by means of the Volta effect. Contrary to Kelvin's theory of the origin of the e.m.f., the author considers that it is due to the chemical action of the medium on the two metals. W. H. Sı.

1296. *Measurement of Small Alternating Currents.* **L. Pillier.** (Lumière Électr. 2. pp. 391–394, June 27, 1908. Ind. Élect. 17. pp. 295–297, July 10, 1908.)—Describes the method employed by the firm of Chauvin and Arnoux. The alternating current is passed through a minute wire spiral surrounding a thermo-element, and the thermo-current produced read off on a d'Arsonval type pointer galvanometer. It is also shown how the method can be used to measure very small powers, by using two equal heating coils joined at one end and in series with a resistance ; the other ends of the coils are led to the potential leads of a shunt included in the main circuit. The power, e.m.f., R.M.S. current, and consequently the phase angle, can readily be determined. The apparatus should be made as small as possible. A spiral of 10 turns of 0·08 mm. constantan wire, 5 mm. long and of 1 mm. internal diam., was used to heat a copper-constantan couple 10 mm. in length and of 0·1 mm. diam. wire. This gave a full-scale reading for 20 milliamps., the temperature of the couple not exceeding 25° C. With four couples in series the same deflection was obtained with 10 milliamps, and the heating was not 5° ; 16 couples would give it for 5 milliamps. L. H. W.

1297. *Binary Electrometer.* **F. Dolezalek.** (Ann. d. Physik, 26. 7. pp. 312–328, June 9, 1908. Physikal. Inst. d. Kgl. Techn. Hochschule, Charlottenburg.)—A description of a binary electrometer based on a principle first propounded by Curie. The two halves of the needle are insulated and oppositely charged and are enclosed by oppositely charged half-cylinders or two hemispheres. A very simple formula holds good for the needle displacement and the proportionality of the deflection ranges over an angle seven times greater than in the quadrant system. The disturbing effect of the lines of force of the electrometer can be considerably reduced in the binary system, thereby rendering possible the use of higher charge-potentials and greater precision of the deflections. By making the needle and surrounding box in the shape of concentric spherical shells, the disturbing of the equilibrium of the needle with high charging-potentials is avoided. F. E. S.

1298. *Autoballistic Repeater.* **A. Guillet.** (Comptes Rendus, 147. pp. 45–47, July 6, 1908.)—The method of repetition, that is, the giving of rhythmic impulses to the moving part of the galvanometer until the amplitude of the oscillation attains its steady value, and then reading this value is not yet used in laboratory practice. The method, however, is of real value as the amplitude of the swing can be multiplied $(1 - \epsilon^{-\lambda T/2})^{-1}$ times by this means, where $\lambda$ is the damping factor, and T the period of vibration of the galvanometer. For example, if $\lambda = 0{\cdot}004$, and $T = 2$ seconds, the amplitude is multiplied 250 times. The impulses obviously must be applied mechanically, and in some cases it is advisable to give a suitable impulse to the moving part initially so as to avoid wasting time over the building up of the oscillation. The author has, in conjunction with V. Guillet, made many types of autoballistic repeaters, both rotational and translational. The author gives the theory of a torsion instrument which can be quickly made. Formulæ proved in a preceding paper [see Abstract No. 1685 (1907)] are utilised. The instrument is specially adapted to study the laws of torsion, eddy currents, friction, &c. It is found that the damping factor $\lambda$ is not a constant, but increases with the amplitude of the oscillations. Great care has to be taken to render the effects of the currents induced in the moving coil negligible so as to avoid increasing the complexity of the formula which is used with the instrument. A. R.

## ALTERNATING CURRENTS AND MAGNETISM.

1299. *Theory of Magnetism.* **O. W. Richardson.** (Phys. Rev. 26. pp. 248–258, March, 1908.)—According to Langevin's electron theory of magnetism the magnetisation of a ferromagnetic substance consists in the orientation of the electronic orbits in accordance with a magnetic field. This orientation creates a moment of momentum about the magnetic axis, and the author shows that the ratio between the moment of momentum per unit volume and the intensity of magnetisation, is the same for all substances and equal to twice the inverse of the specific charge $e/m$ of the negative electrons. He is now conducting experiments with a view to discovering this moment of momentum. A vertical magnetic field is suddenly applied to a long, thin, cylindrical bar of iron suspended by a fibre passing through its axis of figure. The movable orbits will then set so as to leave a balance in favour of the plane perpendicular to the direction of the field. The moment of momentum thus acquired might be made evident by the twisting of the suspended system as a whole. It has, however, not yet been found possible to eliminate disturbing factors. E. E. F.

1300. *Alternate-current Permeability.* **L. Schames.** (Phys. Zeitschr. 9. pp. 317–319, May 1, 1908.)—In works concerned with the dependence of permeability upon frequency the alternate-current permeability as calculated is usually only the mean of the permeabilities obtaining during a whole period. This value cannot be directly compared with the direct-current permeability. In a case calculated by the author the mean value is 1,520 in a specimen in which the direct-current value is 1,300. That is in a field of 10 units. When the field varies the max. of the alternate-current permeability is 15 per cent. below the max. of the direct-current permeability. The two curves intersect at $H = 2{\cdot}8$ and then separate again in the high fields by an amount which reaches as much as 20 per cent. In very strong fields they approach each other asymptomatically. The softer the iron the greater are the differences, and the lower the point of intersection. E. E. F.

**1301.** *The Starting Impulse of Magnetic Disturbances.* **W. van Bemmelen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 10. pp. 778–782, May 26, 1908.)—Having noticed peculiar features in the starting impulses of magnetic storms at Batavia [see Abstract No. 481 (1907)], the author communicated with other observatories as to days selected by himself, and he gives the results of these inquiries concerning the horizontal and vertical components and the declinations. At Buitenzoog the commencement of the movements of the three components (Töpfer-Schulze magnetograph) are frequently not simultaneous. The constancy of a definite sense of the movement decreases with increasing latitude; the constancy is most marked for H (starting impulse always positive) and smallest for D. While places situated near one another are affected in the same sense as regards H and D, the Z may change in the opposite sense; this is so, *e.g.*, for Batavia and Buitenzoog, and for Greenwich (initial impulse positive) and Paris (negative). In Europe we find mostly a N.W. vector, in America a N.E. vector; the centre of the disturbance would thus appear to be situated near Greenland. The local differences in Z would be difficult to account for, if the disturbances were due to electric currents in the higher atmosphere, as the author had first assumed; earth currents, on the other hand, have different directions in North Java and South Java, for instance. The seat of the starting disturbance is, therefore, most probably in the earth itself, and the initial positive current must run E.–W., since the horizontal component is always increased by the first impulse. The magnetic disturbance proper, immediately following upon the initial impulse, must have an extra-terrestrial source, however; the daily variation of magnetic force and auroræ point to that explanation. H. B.

## ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS.

**1302.** *The Measurement of Röntgen Rays.* **W. D. Butcher.** (Röntgen Soc., Journ. 4. pp. 36–45, Feb.; Discussion, pp. 59–71, May, 1908.)—The main consideration of the author is the standardisation of Röntgen-light. He first describes a "penetrometer" for determining the hardness of the rays by a direct comparison of the fluorescent image of the two halves of a metal slit. Over one half of the slit a toothed wheel is caused to revolve, so that the normal intensity of the beam is reduced to half. An Al wedge disc (of gradually increasing thickness) in front of the other half of the slit is then turned until the two images match. The thickness of the Al is then a measure of the hardness of the rays. Thus a No. 5 beam would be defined as the pencil of Röntgen light which is cut down to half value by 1 mm. of Al. Bergonié's electrostatic voltmeter method is then described. As regards quantitative methods, those of Holzknecht, Kienböck, Freund (Bordier and

Galimard), Sabouraud and Noiré, Schwarz, Guilleminot are briefly reviewed and a comparison table given in which their relative indications are compared with that given by the photographic action of light (Scheiner lamp). The questions of a radium candle and a suggested unit of Röntgen illumination (one "Radion") are also considered in the paper and dealt with in the discussion. L. H. W.

## REFERENCES.

1303. *The Mercury Vapour Lamp as Spark-gap.* **K. Markau.** (Ann. d. Physik, 26. 1. pp. 167–200, May 12, 1908. Extract from Dissertation, Berlin.)—The full paper corresponding to Abstract No. 453 (1908).

1304. *Intensity and Damping of Hertzian Waves in Air.* **W. P. White.** (Phys. Rev. 25. pp. 138–139, Aug., 1907. Abstract of paper read before the Amer. Physical Soc.)—A brief account of experiments made with the aid of a bolometer (Pt wire *in vacuo*). L. H. W.

1305. *Action of Light on the Electric Spark.* **V. K. Lebedinskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. 3. pp. 67–69, 1908.)—The author describes various arrangements which permit the two sorts of action of ultra-violet light and radium rays on the electric spark to be observed. In general, the same results are obtained with light from radium as with the ultra-violet light of the electric light. T. H. P.

1306. *Potentiometer Design.* **J. H. Hart.** (Elect. Rev., N.Y. 52. pp. 942–943, June 13, 1908.)—A non-mathematical paper dealing with the theory and development of the potentiometer method of measuring e.m.f. F. E. S.

1307. *Action of Cycles of Tension during Magnetisation.* **C. Maurain.** (Journ. de Physique, 7. pp. 497–506, July, 1908.)—Shows how the behaviour in any case can be predicted from a consideration of the "normal curve of magnetisation" (anhysteretic curve). L. H. W.

1308. *Theory of Electric Excitation.* **L. Lapicque.** (Comptes Rendus, 146. pp. 1054–1057, May 18, 1908.)—Comparison of the author's theory and Nernst's with experiment, and outline of a new theory. [See Abstract No. 688 (1908).]

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1309. *Volatility of Mercury.* **P. Ménière.** (Comptes Rendus, 146. pp. 754–756, April 6, 1908.)—Air in an undisturbed room, kept at 15° C., and containing a vessel of Hg, 90 × 40 cm., is found after 5 days to contain 0·008 gm., and after 15 days, 0·009 gm. per $m.^3$. Air passed over amalgams at temperatures of from 12° to 100° C., showed 0·0004 to 0·19 gm. per $m.^3$, and over metallic Hg, 0·0006 to 0·42 gm. per $m.^3$. The Hg has been estimated by absorbing it in boiling nitric acid, evaporating nearly to dryness, and testing the residue with either diphenylcarbazide or sodium iodide. W. H. St.

1310. *Lecture Experiments with Ozone.* **C. Harries.** (Ber. Deutsch. Chem. Gesell. 41. pp. 42–48, Jan. 18, 1908. Chem. News, 97. p. 89, Feb. 21, 1908.)—A cylinder, 30 cm. in height, filled with ozone is well shaken with 50 c.cm of turpentine-oil; potassium iodide starch-paper, then introduced into the cylinder, remains unchanged, showing that all the ozone has been absorbed. The ignition of turpentine-oil when absorbing ozone is, however, not so easily demonstrated as Ladenburg and Landolt had stated; they soaked cotton wool with the oil. The author charges a wide cylinder with ozone and dips a piece of blotting paper, saturated with turpentine-oil and dried, quickly into the cylinder. The oil ignites after a few seconds, and burns with a dark-red, very sooty flame. H. B.

1311. *Porous Plugs in place of Stop-cocks for Gas Apparatus.* **A. Stock.** (Ber. Deutsch. Chem. Gesell. 40. pp. 4956–4959, Dec., 1907. Deutsch. Phys. Gesell., Verh. 10. 2. pp. 19–20, Jan 30, 1908. From the Chem. Inst. d. Univ. Berlin.)—In 1905 K. Prytz introduced porous plug-valves of fire-brick as a substitute for stop-cocks. A branch tube from the glass vessel to be experimented with is closed by a thin plate of this material which is fixed in with sealing wax and covered with mercury; the tube from the pump or other vessel is also closed by a plug, and the two plugs are pressed against one another. Gases diffuse through the plugs, but mercury is not forced through the pores by a pressure difference of 1 atmo. The author found that the sealing wax was attacked by some gases, that the gas diffusion was slow, and the mercury was not always kept out. He bakes his plugs, 8 mm. in diam., 2 or 3 mm. in thickness, of clay, sodium silicate and some gum, and fuses them directly into the glass. These plugs are not attacked by acids and boiling water, and the diffusion is rapid, up to 800 c.cm. of air at a pressure-difference of 60 cm. Valves of this kind are supplied by Bleckmann and Burger, of Berlin. A piece of stout filter paper over which some mercury is poured can also act as valve. H. B.

1312. *Chemical Action of Radium Emanation.* III. **A. T. Cameron** and **W. Ramsay.** (Chem. Soc., Journ. 93. pp. 966–992, June, 1908.)—The chemical action of the emanation on water and certain gases is described. In the apparatus used both gas and water phases were kept constant, the changes in the amount of gas being read by the pressure it exerted. The curve showing rate of decomposition was exponential, and the period representing the total action approximated more closely to that of the half-decay of the emanation (3·86 days) the more exact the experimental data. Similar results were obtained for the recombination of hydrogen and oxygen, and observations were extended to other gases. The results may be regarded as preliminary. It was found that $CO_2$ is decomposed into carbon, oxygen, and CO; CO into carbon, oxygen, and $CO_2$; ammonia into nitrogen and hydrogen in considerable quantity. Hydrogen chloride is decomposed into hydrogen and chlorine. So far the only gas tested in which the action of the emanation was not discernible is steam, this being remarkable in view of the comparatively rapid decomposition of water in the same circumstances. The chief conclusion reached is that whenever radium emanation produces chemical action, then, other conditions being unaltered, each particle of emanation as it disintegrates produces the same amount of change. Many chemical actions are brought about by the silent electrical discharge, by ultra-violet light, and by the action of the $\beta$-rays from radium preparations. The changes described in the present paper are of the same nature, but the degree of action is far greater. This is explicable on the assumption that the actions are brought about by the $\alpha$-particles. Experiments were carried out at 180°, and these do not altogether support this view. The action on steam should be analogous to that on HCl, which is decomposed. But no action was noted. This may be due to recombination of the hydrogen and oxygen at the temperature of the experiment. The paper is concerned with atomic changes. Whether when the emanation produces these some part of the energy is utilised in disintegrating the atoms, is a different problem. [See also next Abstract.] J. J. S.

**1313.** *Chemical Action of Radium Emanation* (*on Water*). IV. **A. T. Cameron** and **W. Ramsay.** (Chem. Soc., Journ. 93. pp. 992–997, June, 1908.)—In the second part [Abstract No. 140 (1908)] an account was given of some experiments in which water and solutions of copper salts were treated with emanation and the resulting products examined. It appears that in presence of water the emanation disintegrates into neon; with copper solutions into argon. There was some indication that minute traces of copper were transmuted into lithium, and possibly also into sodium. The experiments were carried out in bulbs of potash-lime and soda-lime glass. They have been repeated with a bulb of very pure silica, of which the material had been boiled for half an hour before fashioning in order to remove alkalies by volatilisation. In the experiment two or three c.cm. of pure water were used. The water was mixed at intervals with the emanation. The nitrogen residue was examined for rare gases. The part not condensable in charcoal at liquid-air temperatures showed helium and neon. The He yellow line was extremely intense, and the strongest Ne reds had about two-thirds that intensity. The spectrum was photographed twice. The Ne spectrum faded rapidly, and was barely visible during the second photograph. A list of the lines observed spectroscopically is given. The total volume of gas (He and Ne) in the spectrum tube was approximately 0·8 $mm.^3$. The presence of argon may be due to slight leakage of air. The Ne present must be due to transmutation. The only other possible source is the Al of the electrodes. The vacuum tube had been previously run a great number of times at different pressures, washed out with air, and finally showed traces of hydrogen, and hydrogen alone. It is inconceivable that Ne can have resulted thus by chance from two experiments with water where in each case the residues were tested between those from numerous similar experiments with other solutions in which no Ne was detected. The authors regard the transformation of emanation into neon, in presence of water, as indisputably proved, and if a transmutation be defined as a transformation brought about at will, by change of conditions, then this is the first case of transmutation of which conclusive evidence is put forward. In later experiments an examination was made of the accumulated residues of the gases pumped away from solutions of radium bromide, after removing hydrogen and oxygen by sparking, and the emanation in the usual manner. The heavier fraction was removed with charcoal cooled to liquid-air temperature. The lighter fraction consisted largely of helium. Neon was undoubtedly present. J. J. S.

**1314.** *Colouration of Glass and Quartz by Radium.* **C. E. S. Phillips.** (Nature, 77. p. 535, April 9, 1908.)—Attributes the colouration to traces of manganese, lead, or other foreign substance. Pure boric acid and powdered silica show no colouration in a month or more. The radium colouration may serve as a new test for the purity of glasses. E. E. F.

**1315.** *Behaviour of Metals when Heated in Ammonia.* **G. G. Henderson** and **J. C. Galletly.** (Soc. Chem. Ind., Journ. 27. pp. 387–389, April 30, 1908. Paper read before the Scottish Section.)—All metals when heated in dry ammonia gas form nitrides or amides at least transiently; in many cases the temperature of decomposition of the nitride or amide is near to that of the reaction between the metal and ammonia, and generally the nitride is reduced by heating in hydrogen. If the nitride itself is not thus obtainable, the metal shows physical changes after the treatment, such as a spongy surface, or indications of partial fusion, although the temperatures employed are much below the melting-point of the metal, and the ammonia is always in part decomposed, indicating that the action has occurred. Mn is almost completely converted into $Mn_3N_2$ in ammonia at 800°. Cr and Mo form nitrides, W is only slightly affected. Ti forms a nitride, Sn and Pb only react slowly. Zn forms a nitride readily, Cd with more difficulty. Only a small proportion of Al remains in the state of nitride, the remainder being found to be spongy. Pd is but slightly affected by heating to redness in ammonia. F. R.

**1316.** *Reduction of Lead, Cadmium, and Bismuth Oxides, and Existence of the Suboxides.* **F. J. Brislee.** (Chem. Soc., Journ. 93. pp. 154–164, Jan., 1908.)—Tanatar's observation that the suboxides of Pb, Cd, and Bi exist is confirmed by experiments on the velocity of reduction of the oxides of the metals by CO. The suboxides are formed as an intermediate stage in the reduction, but it has not been shown under what conditions they are stable. The question is under investigation as to whether the velocity of the change $Pb_2O \longrightarrow Pb + PbO$ increases gradually with temperature, or whether there is a definite transition temperature. F. R.

**1317.** *Tellurium.* **W. Bettel.** (Chem. News, 97. pp. 169–170, April 10, 1908.)—Contains an appeal for samples of telluride silver ores giving peculiar reactions, which, it is thought, may be due to the presence of a new element with the Te. At the completion of cupellation of lead buttons from the type of ores sought, the beads of silver brightened and cleared, but instead of solidifying to buttons in the usual manner they suddenly lost their surface tension and spread out in irregular films, leaving a protuberance in the centre of each cupel. In some instances the films were over 1 in. in diam., whereas those obtained from so-called "chemically pure" Te, when alloyed with lead and silver, after scorification and cupellation, were generally 0·5 to

1 mm. in diam. The element present in the originally examined ore possessed the following properties: (1) It formed a true chemical compound with Ag, less easily oxidisable than Pb, Bi, Te, Se, Sb, &c. (2) It prevented the absorption of oxygen by Ag at the close of the cupellation. (3) It was not finally removed by repeated cupellation with Pb or Bi, even after allowing the silver bead to remain fluid long after "finishing." (4) It was soluble in sulphuric acid, and imparted the same tint as ordinary Te. C. O. B.

1318. *Sulphides of Lead, Copper, Silver, and Iron.* **K. Friedrich.** (Metallurgie, 5. pp. 23–27, Jan. 8, and pp. 50–58, Jan. 22, 1908. Communication from the Metallog. and Metallurg. Laborat. d. kgl. Bergakademie, Freiberg.)—The results of the author's experiments lead to the following solidification-points with possible error of ± 10° C.: PbS, 1,120°; $Cu_2S$, 1,135°; $Ag_2S$, 812°; FeS, 1,171° C. The causes of so wide a range of uncertainty are discussed at length; it may be due to low thermal conductivity of sulphides, or to supercooling. Very slow cooling may mask a maximum. If the melt separates into layers a second halt-point may be observed. The solidification covers a wide interval; even with melts whose total composition corresponds to that of pure sulphide it cannot be affirmed that the interval is less than with different sulphur content. The addition of S to $Ag_2S$, FeS, and also possibly PbS, raised the solidification-point; in the case of $Cu_2S$ the opposite effect occurred. The author is led to doubt that in the case of either of the four sulphides named we have a chemical compound. F. R.

1319. *Nickel and Sulphur.* **K. Bornemann.** (Metallurgie, 5. pp. 13–19, Jan. 8, 1908. Communication from the Inst. f. Metallhüttenw. u. Elektrometall. d. Kgl. techn. Hochschule, Aachen.)—The temperature-concentration diagram of nickel and sulphur is given up to 31 per cent. S. Beyond 31 per cent. the sulphur tension of the melt exceeds 1 atmo. Only one compound is formed which is stable in the molten state, viz., $Ni_3S_2$, melting-point 787° C. At lower temperatures the existence of the following compounds is confirmed: NiS, $Ni_3S_4$, $NiS_2$, and very probably $Ni_6S_5$. The alleged compound $Ni_2S$ does not exist, but at this composition the eutectic (644°) of mixed crystals of Ni in $Ni_3S_2$ and of $Ni_3S_2$ in Ni is found. The series of mixed crystals of $Ni_3S_2$ in Ni is well marked, but changes occur in cooling through 583°, which are only in part hindered by quenching; hence at the ordinary temperatures up to 26·7 per cent. S the substances are mechanical mixtures of Ni and $Ni_3S_2$, and from 26·7 to 31 per cent. S mixtures of $Ni_3S_2$ and $Ni_6S_5$. Above 24 per cent. S these changes after solidification are somewhat complex. Microstructure and specific gravity data of slowly cooled and quenched specimens are given in support of the general conclusions. [See also next Abstract.] F. R.

1320. *Constitution of Nickel Ore.* **K. Bornemann.** (Metallurgie, 5. pp. 61–68, Jan. 22, 1908. Communication from the Inst. f. Metallhüttenw. u. Elektrometall. d. Kgl. techn. Hochschule, Aachen.)—I. *System:* FeS — $Ni_3S_2$.—The melts of this system, and of Ni — S, high in sulphur, and FeS itself, lose sulphur by dissociation. FeS however, melted with excess of S, attains a higher melting-point. Pure FeS melts at 1194° C. The molecular lowering of the solidification-point is 1085, and the latent heat of melting is 31·9 gm.-cals. per gm. The temperature-concentration diagram of the system FeS — $Ni_3S_2$ is given. The existence of the definite compound $(FeS)_2Ni_3S_2$, melting-point 840°, is indicated; upon melting it undergoes marked dissociation into FeS and $Ni_3S_2$. $Ni_3S_2$ forms a continuous series of mixed crystals with the compound; FeS only forms a series of low concentration. All of these undergo complex changes after the completion of solidification. Micrographic and specific gravity results support the conclusions. II. *System :* FeS — *so-called* $Ni_2S$.—The diagram for this system is given. Although no compound of the formula $Ni_2S$ exists in the free state, yet in combination with FeS the double sulphide $(FeS)_2Ni_2S$, solidifying at 886°, is formed. This compound is only stable at high temperatures; it decomposes at 575° into $(FeS)_3(Ni_2S)_2$ and FeS. At a lower, but indeterminate, temperature this double sulphide recombines with excess FeS to form $(FeS)_4Ni_2S$; this change is not accompanied by any marked thermal effect, and was only indicated by the micrographic and specific gravity work. It is necessary to study samples containing less FeS than $(FeS)_2Ni_2S$ above 575°, or less FeS than $(FeS)_3(Ni_2S)_2$ below 575°, as ternary systems. It can be inferred from the results given in the preceding Abstract upon the system Ni — S that on the "$Ni_2S$" side free Ni will separate in increasing amount. It is remarked that some of the compounds mentioned in this and the preceding Abstract have not been observed to occur naturally. The usual view that Ni always occurs as NiS, not as $Ni_2S$, is incorrect. The probable constitution of ores of different sulphur content is stated in accordance with the results. F. R.

1321. *Viscosity of Zinc-Cadmium Alloys.* **W. Voigt.** [Experimental work by **J. Miller.**] (Phys. Zeitschr. 9. pp. 256–258, April 15, 1908.)—Endeavours to ascertain whether any viscosity and elasticity effects show a parallel with the V-shaped curve of the fusing-points of zinc-cadmium alloys. The figures obtained are only roughly approximate, but they go to show that the elasticity varies regularly with the proportions of zinc and cadmium. The viscosity, on the other hand, is greatest in the eutectic alloy. From the maximum it falls a little towards the cadmium side, and very rapidly towards the zinc side. E. E. F.

1322. *Fusion Curve of Binary Mixtures.* **D. Mazzotto.** (N. Cimento, 15. pp. 401–422, May, 1908. Istituto d. R. Univ. Modena, Jan., 1908.)—From an investigation of alloys of Pb with Sn, Hg, and Bi, and of Sn with Zn and Bi, the author concludes that the melting-point of a binary mixture calculated from le Chatelier's formula, may be brought nearer to that experimentally determined by applying a correction for the polymerisation of the dissolved metal, and also for the heat developed or absorbed on mixing one metal with the other, provided this is due entirely to simple dilution and not to any chemical change. W. H. Si.

1323. *Alloys of Antimony with Iron and Cadmium.* **N. S. Kurnakow** and **N. S. Konstantinow.** (Zeitschr. Anorg. Chem. 58. 1. pp. 1–22, May 6, 1908. Polytechn. Inst., Laborat. f. allgem. Chemie, St. Petersburg.)—Analogies between compounds of Sb with hydrogen and with metals are first discussed, and the paper then gives freezing-point curves, illustrated by photomicrographs of the two series, Sb-Fe and Sb-Cd. In the Sb-Fe series an Sb-rich eutectic is found at 1·5 per cent. Fe with a freezing-point 628°, this eutectic is found in alloys containing up to 28 per cent. Fe. With 41.2 per cent. Fe the compound $Fe_3Sb_2$ is obtained showing a max. point on the curve at 1,014°. At 50 per cent. Fe an Fe-rich eutectic is met with a freezing-point 1,002°; this eutectic is found in all alloys containing between 50 and 90·6 per cent. Fe. The alloy corresponding to $FeSb_2$, when cooled down slowly from

1,000° to 800°, does not show a homogeneous structure, but contains dendrites of $Fe_3Sb_2$, this change taking place at about 782°; when, however, the alloy is kept for 30 hours between 628° and 782° in an electric furnace a homogeneous structure is obtained showing that the following reversible reaction takes place: $Fe_3Sb_2 + 4Sb \rightleftarrows 3FeSb_2$. The crystallography and chemical constitution of this compound $FeSb_2$ is discussed. The Sb-Cd series of alloys resembles the Fe-Cd series in many respects. An Sb-rich eutectic occurs with 58 per cent. Sb, having a freezing-point at 445°; the compound CdSb is found at 52 per cent. Sb and has a freezing-point 455°. From 36 to 7·5 per cent. Sb the compound $Cd_3Sb_2$ first falls out, the remainder of the alloy forming an eutectic which occurs at 7·5 per cent. Sb, with a freezing-point 290°. From 7·5 to 0 per cent. Sb pure Cd is found in the above-mentioned eutectic. The crystallography of these compounds is discussed. C. O. B.

**1324.** *Silicon-Aluminium Alloys.* **W. Fraenkel.** (Zeitschr. Anorg. Chem. 58. 2. pp. 154–158, May 25, 1908. Metallograph. Mitteil. aus d. Inst. f. physikal. Chemie. d. Univ., Göttingen.)—The constitution of these alloys has been studied by the method of thermal analysis. Aluminium lowers the solidification-point of Si, and Si lowers that of Al, the two branches of the curve meeting in a eutectic point at 577° C. and a composition corresponding to about 10 per cent. Si. The limit of solubility of Al in Si is about 2 per cent.; that of Si in Al below 0·5 per cent. Like Bi, Si appears to expand during crystallisation. F. C. A. H. L.

**1325.** *Manganese and Phosphorus.* **S. Żemcżużny** and **N. Efremow.** (Zeitschr. Anorg. Chem. 57. 3. pp. 241–252, March 4, 1908. Translation from Ber. d. St. Petersburger Polytechn. Inst., 7, 50, 1907.)—A study of the binary system manganese-phosphorus, by cooling curves and microstructure, up to 46·92 atoms per cent. P. There are two eutectics, viz., at 964° C. with 9·5 atoms per cent. P, and about 1,095° with 40·5 atoms per cent. There is a well-marked compound, $Mn_5P_2$, solidifying at 1,400°, and very probably there is another, MnP, solidification temperature about 1,190°. There are no solid solutions of Mn and $Mn_5P_2$, but in the next range, $Mn_5P_2$ — MnP, the solid solubility is considerable. The latent heat of fusion of Mn is calculated to be 27·5 gm.-cals. per gm. Samples containing free $Mn_5P_2$ (*i.e.*, over 9·5 atoms per cent. P) are magnetic. The max. effect occurs with pure $Mn_5P_2$. F. R.

**1326.** *Manganese and Manganese-Carbon Alloys.* **A. Stadeler.** (Metallurgie, 5. pp. 260–267, May 8, and pp. 281–287, May 22, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—The commercial sample of manganese used for the experiments contained the following percentages: Mn 95·8, Fe 1·05, Al 1·46, Si 1·30, C 0·00. The melting-point was 1,207° C. and the sp. gr. 7·089. There were no thermal critical points in the cooling of the sample after solidification. Mn is saturated when it contains 6·72 per cent. C; this corresponds to $Mn_3C$ whose sp. gr. is 6·888. With increase of C up to 3·32 per cent. the solidification temperature rises to 1,271°, and falls with further increase to 1,217° with 6·72 per cent. C. A continuous series of solid solutions is said to be formed in this range. With less than 3·32 per cent. C the structure is polygonal grains, and with higher carbon acicular crystals. Samples with from 0·72 to 3·60 per cent. C have a critical transformation at from 817° to 855°, at which temperature another solid solution is formed, and the alloys then consist of two solid solutions. As Mn cannot be carburised with pure carbon it is considered that the carbon occurs in the alloys as $Mn_3C$ dissolved in Mn. Cooling curves and numerous photomicrographs accompany the paper. F. R.

**1327.** *Heat Treatment of Brass and Bronze.* **E. A. Lewis.** (Soc. Chem. Ind., Journ. 27. pp. 479–481; Discussion, pp. 481–482, May 30, 1908. Paper read before the Birmingham Section.)—Alloys used by sand casters may be divided into two types, gun-metal alloys and brass alloys. Gun-metal alloys are the more difficult to cast. Brass alloys will give good castings at lower temperatures than gun metals. Complicated or very small castings require much higher temperatures than plain or large ones. Annealing of rolled brass requires care; the higher the copper content the more heat the brass will stand, and the purer the metal the more heat will it stand without burning. Thin sheets will not stand so much heat as thick ones of the same composition. It is always safest to use the purest Cu for all brass alloys for rolling or for tube-drawing. Arsenic must not be present over 0·05 per cent., Sb over 0·01 per cent., or Bi over 0·005 per cent. Arsenical copper should never be heated above 750° in any part of the rolling process, while refined oxidised copper with 0·1 to 0·2 per cent. oxygen can be heated to 900° without injury. On the other hand, the copper tubes made from very pure copper in pots, deoxidised with phosphorus, should not be heated above 700°. As a rule, the lower the temperature at which Cu is rolled and annealed the tougher and better is the manufactured product; also the thinner the article the lower must be the temperature of working. This paper also contains useful information on the examination of oils, fuels, and raw metals used in the copper and brass industries, on the selection of scrap metals, and on the treatment of residues. C. O. B.

**1328.** *Corrosion of Steel.* **A. S. Cushman.** (Frank. Inst., Journ. 165. pp. 111–120, Feb., 1908.)—An outline of electrolytic theory of corrosion. Upon immersion of a piece of steel in a solution of potassium ferricyanide and phenolphthalein containing agar jelly, both blue and red nodes appear on the steel, demonstrating the local nature of corrosion, and formation of ferrous and hydroxyl ions. [See also Abstract No. 144B (1906) and next Abstract.] F. R.

**1329.** *Corrosion of Iron.* **A. S. Cushman.** (Amer. Electrochem. Soc., Trans. 12. pp. 403–408; Discussion, pp. 408–409, 1907. Abstract of Report published in Bull. No. 30, Office of Public Roads, Dept. of Agriculture. Elect. Engin. 41. pp. 701–702, May 15, and p. 737, May 22, 1908.)—In addition to the "ferroxyl" indicator mentioned in the preceding Abstract, another method of showing the local centres of corrosion depends on the fact that the colloidal ferric hydroxide will migrate towards the negative pole. Hence at a negative centre a cone, and at a positive centre a crater, of hydroxide is formed. These phenomena are shown by low-power photomicrographs in the original report. F. R.

**1330.** *Special Steels.* **L. Révillon.** (Rev. de Métallurgie, 5. pp. 53–68, Feb., 1908. Metallurgie, 5. pp. 217–223, April 22, 1908. Abstract.)—Consists of a detailed paper on the special steels used in automobile construction, giving tables of mechanical tests of the different steels used for various parts, together with curves showing the effect of tempering at various temperatures on some of these special steels. The following six classes are considered:

(1) Cement steels, containing Ni and sometimes Cr. (2) Steels which are used in the natural condition or after annealing; these consist of Ni steels containing 8 per cent. Ni, 5–6 per cent. Ni and 30–36 per cent. Ni, the latter being used for valves. (3) Steels, which after quenching are used with or without a subsequent tempering; this class includes Ni-Cr steels used for toothed wheels and axles. (4) Spring steels, the latest material used for this purpose, contains W, but there seems to be no special advantage over the Mn-Si steels mostly used, containing 2 per cent. Si and 0·45 per cent. C. (5) Magnet steels containing W; there is a tendency to increase the carbon in this class. (6) Axle steels, containing Cr. Steels containing W and V are also being used by some manufacturers. C. O. B.

1331. *Piping and Segregation in Steel Ingots.* (Amer. Inst. Mining Engineers, Bull. 21. pp. 395–426, May, 1908. Discussion.)—[For H. M. Howe's paper see Abstract No. 1231 (1907).] **P. H. Dudley** states that he has found that casting ingots large end up gave favourable results. More time than usual must be allowed either in the converter or ladle before pouring, in order to produce sound ingots by giving a chance for entrained impurities to rise to the top. In this respect the open-hearth process has a special advantage when compared with the Bessemer process. **H. M. Howe** points out that the electric furnace gives a similar advantage. **A. A. Stevenson** discusses the features of the paper seriatim with particular reference to the manufacture of tyres rolled from ingots whose inner liquid portion is poured out shortly after casting. He finds that segregation is more marked in small than in large ingots. Analyses at numerous points in a 20-in. diam. ingot show considerable uniformity of composition. Sections of a 10-in. and a 20-in. ingot, bottom-poured in the same group show that the larger ingot has a much deeper pipe than the smaller. The view that depth of pipe is decreased by casting with large end up is confirmed. Blowholes in tyre steel lead to shelling, but a paper by G. L. Norris (Western Railway Club, Oct., 1907) is quoted in which extensive tests are given to show that shelling is due rather to severe conditions of service than to metallurgical defects. In most respects Stevenson agrees with Howe. F. R.

1332. *Theory of Optical Rotation.* III., IV., V. [*Theory of Solutions,* Parts I., II., and III.] **C. Winther.** (Zeitschr. Phys. Chem. 60. pp. 590–625, Oct. 1; 641–705, and pp. 756–757, Oct. 8, 1907.)—The author develops in these three papers a theory of optical rotation, the main feature of which is the assumption that the rotatory power of an active compound (apart from polymerisation and association with the solvent) is affected only by the pressure—internal and external—of the solution. Actual data are very scarce, and the main contents of the present paper are indirect results arising from the main hypothesis. It appears that the effects of different solvents on the rotatory power of nicotine and ethyl tartrate are in the order of the internal pressures, although the latter are almost unknown quantities so far as absolute magnitude is concerned. The papers contain a classification of optically active substances into those that are homogeneous, and those which are heterogeneous, containing two or more types of active molecule. Nicotine is taken as containing one type, ethyl tartrate in most solvents two types, and ethyl tartrate in benzene as containing more than two types of active molecule. The tests applied are: (1) When one type of active substance is present there is a linear relationship between rotatory power and molecular volume, when the latter is altered (*a*) by changes of temperature, (*b*) by changes of concentration; but when the alteration is due to change of solvent there is merely an agreement in order of magnitude, as shown by Patterson, but no direct proportionality. (2) In the case of simple active substances the rotatory dispersion is independent of the concentration and of the solvent. When two types of active molecules are present the rotatory dispersion varies with the solvent, but if the *difference* of rotatory power between solution and solute is considered the dispersion is again independent of the solvent. If more than two types are present both the rotatory dispersion and the dissolution dispersion vary with the concentration. The author calls attention to the importance of optical rotation for the study of solutions owing to the fact that one constituent of a liquid mixture can thus be studied separately, the other constituent merely entering into the observations in so far as it affects the properties of the active ingredient. [See also Abstract No. 503 (1907).] T. M. L.

1333. *Critical Temperatures of Solutions.* III. *Solutions in Methyl Chloride, Ethyl Ether, and Methyl Alcohol.* **M. Centnerszwer.** (Zeitschr. Phys. Chem. 61. pp. 356–365, Dec. 8, 1907. Phys. Chem. Laborat. des Polytechn. Inst., Riga, Sept., 1907.)—Attempts have been made to utilise the "critical temperatures" of liquids (*i.e.*, the temperatures above which separate vapour and liquid layers are no longer formed) for the determination of molecular weights, using formula of the same type as those which govern the elevation of the boiling-point and depression of the freezing-point. It is now shown (1) that the elevation of the critical temperature is not strictly proportional to the concentration of the solute; (2) that the molecular elevation is affected both by the nature of the solvent and by the nature of the solute, and (3) that the molecular depression is smallest when the critical temperature of the solvent and solute are near together. T. M. L.

1334. *Adsorption and Occlusion. Nature of the so-called Solid Phase.* **M. W. Travers.** (Zeitschr. Phys. Chem. 61. pp. 241–254, Nov. 26, 1907. From the English.)—Attention is called to the importance of distinguishing carefully between "solid solutions" which are isomorphous mixtures of crystalline materials, and mixtures of amorphous materials, which owing to the absence of crystalline form should be classified with ordinary liquid mixtures or solutions. Most of the cases of adsorption and occlusion that have hitherto been studied belong to the latter class, *e.g.*, the adsorption of water-vapour by cotton and wool, of gases and solutes by charcoal, and in certain cases of solutes by precipitates. Metals which absorb gases in the liquid state usually liberate them when they crystallise; this is probably true even in the case of hydrogen and Pd since new Pd-foil does not absorb hydrogen, but requires preliminary treatment by repeated heating and cooling in the blowpipe, whereby it is possibly converted into the amorphous condition. The carrying down of Mg by calcium oxalate, which obeys a simple linear law of concentration, probably depends on isomorphism. **H. Freundlich** (ibid. pp. 249–254) observes with reference to Travers' paper that the temperature-coefficient of absorption of aqueous acetic acid by charcoal is almost as great as in the case of gaseous $CO_2$, but this is believed to be an abnormal case. T. M. L.

1335. *Condition of Substances dissolved in Absolute Sulphuric Acid.* **A. Hantzsch.** (Zeitschr. Phys. Chem. 61. pp. 257–312, Dec. 3, 1907.)—Absolute sulphuric acid cannot be prepared by ordinary analysis, but an approximately correct acid can be made absolute by cautiously adding traces of water or acid until the freezing-point is raised to 10·46°; this value was obtained in the majority of 20 series of experiments, and is probably correct within about 0·01°. Pictet gives 10·5°, and Bredig 10·48°. The absolute acid has little tendency to overcool, and crystallises readily at 10·2–10·8°. It has a minimum conductivity 0·0097 reciprocal ohms per cm.$^3$. The molecular depression is 70·02, and the molecular heat of fusion is calculated to be 22·94 cals., agreeing closely with a hitherto unpublished determination of Knietsch, which gave 22·82. Substances which dissolve in sulphuric acid with normal molecular weight as non-electrolytes without increasing the conductivity include the nitro-derivatives of benzene, dimethyl sulphate, and phthalic anhydride, as well as oxalic, picric, and trichloroacetic acids. Substances which increase the conductivity and produce an abnormally great freezing-point depression when dissolved in sulphuric acid include the sulphates of the alkalies of ammonium, thallium, and barium ($BaSO_4$ is slightly soluble in concentrated acid), organic ammonia-derivatives even when slightly acidic in character, most oxygen compounds, such as water, alcohol, ether, fatty esters, aldehydes, boric anhydride, and many carboxylic acids. It is remarkable that *many electrolytes exhibit in sulphuric acid solutions a constant molecular weight and a constant molecular conductivity.* The conductivity of the oxygen compounds is attributed to the formation of ionised oxonium salts, analogous to the ammonium salts, *e.g.*, in the case of water—

$$(OH_3)HSO_4 \rightleftarrows OH_3^+ + HSO_4^-$$

$$\text{cf.}\quad (NH_4)HSO_4 \rightleftarrows NH_4^+ + HSO_4^-$$

T. M. L.

**1336.** *Osmotic Pressure of Concentrated Solutions.* **G. N. Lewis.** (Amer. Chem. Soc., Journ. 30. pp. 668–688, May, 1908. Contributions from the Research Lab. of the Massachusetts Inst. of Technology, No. 25.)—The exact relationship between osmotic pressure and freezing-point depression is—

$$\pi = 12{\cdot}06\Delta - 0{\cdot}021\Delta^2.$$

By means of this equation, the accuracy of which depends mainly on a knowledge of the latent heat of fusion of ice, it is possible to calculate osmotic pressures with considerably greater accuracy than can be attained by direct measurement. On comparing the direct measurements of Morse and Fraser with values deduced from their freezing-point measurements, it is found that the deviations in the case of cane sugar never exceed 0·2 atmo. on values ranging up to 25 atmos.; in the case of glucose the deviations amount to 0·5 atmo. on a similar range. The temperature-coefficient of osmotic pressure can be calculated from the equation—

$$\pi - q = T a\pi/dT,$$

where $q$ is the heat of dilution (*i.e.*, the heat evolved when 1 c.cm. of solvent is added to a large quantity of the solution) expressed as energy. For cane sugar this gives a coefficient 0·27 per cent., instead of the theoretical value 0·35 for a gas or an ideal solution; in other cases, however, when $q$ has a larger value, the temperature-coefficient may be much smaller, and might even have a negative value, thus affording an explanation of the remarkable observation of Morse and Fraser that cane sugar gives the same osmotic pressure at 0° and at 25° C. The osmotic pressure can also be calculated from the vapour-pressure by the equation—

$$\pi - \tfrac{1}{2}a\pi^2 = (\mathrm{RT}/\mathrm{V}_0)\log(p_0/p),$$

where $a$ is the coefficient of compressibility of the solvent, $\mathrm{V}_0$ its molecular volume, $p_0$ its vapour-pressure, and $p$ the vapour-pressure of the solution. In considering an ideal solution, not infinitely dilute, it is possible to establish as a criterion (1) van't Hoff's law $\pi = \mathrm{RT}/\mathrm{V}$; (2) Morse and Fraser's modification, in which V is taken to be the volume of solvent mixed with 1 gm.-mol. of solute instead of the volume of solution containing this quantity; (3) Raoult's law that the lowering of the vapour-pressure is proportional to the percentage of solute molecules in the solution; or (4) Henry's law. The author prefers to establish the vapour-pressure law as a criterion, mainly because it can be shown to hold good in some instances over the whole range from 0 to 100 per cent.: thus if benzene is taken as solvent the molecular weight of ethylene chloride works out at 99 ± 1 over the whole range from 0·5$g$ $C_2H_4Cl_2$ to 14·54$g$ $C_2H_4Cl_2$ to 1 gm. of benzene. This leads to a formula for the osmotic pressure—

$$\pi - \tfrac{1}{2}a\pi^2 = -\frac{\mathrm{RT}}{\mathrm{V}_0}\log(1 - \mathrm{N}),$$

where N is the proportion of solvent molecules in the solution; up to normal solutions (o.p. = 24 atmos.) this agrees closely with Morse and Fraser's formula, but at higher concentrations very much larger deviations are found. Thus in the case of ethylene chloride in benzene, where the osmotic pressure deduced from the vapour pressure was found to be 785 atmos., the author's formula gave 743, whilst van't Hoff's formula gave 268 and Morse and Fraser's gave 3,292. T. M. L.

**1337.** *Catalytic Decomposition of Hydrogen Peroxide under Oxygen at High Pressures.* **E. B. Spear.** (Amer. Chem. Soc., Journ. 30. pp. 195–209, Feb., 1908. Dissertation, Heidelberg, 1907.)—The catalytic decomposition of $H_2O_2$ by colloidal Pt, Pd, Ir, Au, and Ag under high pressures of oxygen was studied. The chief results obtained were: (1) A method for determining reaction velocities under high gas pressures was worked out, employing a special "bomb" vessel; (2) it was experimentally shown that the catalytic decomposition of $H_2O_2$ by colloidal solutions of the above-named metals was not appreciably affected by increasing the pressure of the oxygen gas above the reaction mixture from 1 to 200 atmos. F. J. B.

**1338.** *Studies of Dynamic Isomerism. VI. Influence of Impurities on the Mutarotation of Nitrocamphor.* **T. M. Lowry** and **E. H. Magson.** (Chem. Soc., Journ. 93. pp. 107–119, Jan., 1908.)—The experiments described in reference to nitrocamphor are similar to those made with glucose [Abstract No. 285 (1904)]; nitrocamphor has the advantage of exhibiting mutarotation in a much larger number of solvents than glucose. Water is found to have a large effect in accelerating the isomeric change of nitrocamphor dissolved in alcohol, acetic acid, or ether. The action of alkalies varies considerably, the nitrocompound being excessively sensitive to the most minute quantities of piperidine, but only slightly affected by the addition of considerable quantities of aniline to the benzene solutions; sodium ethoxide in alcoholic solution produces an intermediate acceleration comparable with that arising from the addition of potassium hydroxide to aqueous solution of glucose.

Neutral salts, such as common salt, have a marked accelerating action. Acetic acid and trichloracetic acid cause an isomeric change; in the case of a decinormal solution of trichloracetic acid a further large change of rotary power was caused by the conversion of the nitrocompound into the isomeric camphoryloxime. D. H. J.

**1339.** *Studies of Dynamic Isomerism. VII. Action of Carbonyl Chloride as an Agent for arresting Isomeric Change.* **T. M. Lowry** and **E. H. Magson.** (Chem. Soc., Journ. 93. pp. 119–132, Jan., 1908.)—The inhibition of the mutarotation of nitrocamphor dissolved in chloroform was pointed out in 1899; in one case a 10 per cent. solution was kept in a polarimeter tube for a week without the slightest alteration of rotary power. It has now been found that the active agent in arresting the isomeric change in chloroform solutions is carbonyl chloride, which is produced by oxidation of the solvent in sunlight or in presence of acids. By adding small quantities of carbonyl chloride it is possible to arrest the isomeric change in other solvents such as benzene or ether. The authors advance the view that a catalyst is necessary in all cases of isomeric change. D. H. J.

**1340.** *Solid Solutions in the Dissociation of Iridium Oxides.* **L. Wöhler** and **W. Witzmann.** (Zeitschr. Elektrochem. 14. pp. 98–107, Feb. 28, 1908. Chem. Inst. d. techn. Hochschule, Karlsruhe.)—The authors have determined the dissociation pressures of iridium dioxide at different temperatures, and find that as oxygen is withdrawn from the system there is a continuous fall of pressure, pointing to the formation of a homogeneous solid solution. At the dissociation temperature and pressure of the dioxide both the sesquioxide and the monoxide are unstable, the dioxide dissociating into metal and oxygen. The best temperature for carrying out the oxidation of metallic iridium to dioxide by oxygen is 1,070°. As the decomposition of the dioxide is continued, two solid solutions are formed, and the dissociation pressure then becomes constant, as found by Deville and Debray. A. F.

**1341.** *Specific Heat and Dissociation of Chlorine.* **M. Pier.** (Zeitschr. Phys. Chem. 62. 4. pp. 385–419, April 10, 1908.)—To ascertain whether the high value for the molecular heat of chlorine is connected with its abnormal density, the author has studied the behaviour of this gas at various temperatures and pressures. Taking the density at 0° and 1 atmo. pressure as 2·49 (air = 1) [compare Moissan], the densities at higher temperatures are found to be: 2·4688 at 50·24°, 2·4601 at 100·4°, 2·4554 at 150·7°, and 2·4538 at 184·0°. Under about 0·1 atmo. pressure, the density has the theoretical value 2·4494. Assuming that the abnormal density of chlorine is due to partial association to $Cl_4$ molecules, the variation of the density, $\Delta$, with the pressure, P, in atmos. and with the absolute temperature, T, is given by the formula: $\log(\Delta - 2{\cdot}4494) = 463{\cdot}11/T - 0{\cdot}6415 - \log T + \log P$, which gives numbers agreeing well with the experimental values. By means of this formula, the correction to be applied to the observed molecular heat of chlorine to obtain the value for the non-associated gas amounts, even at ordinary temperatures, only to 0·3–0·5 cal., so that the high specific heat of chlorine cannot be due to its abnormal density. From 300° to 1,450° chlorine has the normal density, the degree of association being practically zero. Determinations of the specific heat of chlorine show that Regnault's value is distinctly too high, the experimental values up to 1,450° being given by the formula: $C_v = 5{\cdot}431 + 0{\cdot}0005\,T$. These values are, however, greater than those of most diatomic gases, for which $C_v = 4{\cdot}827 + 0{\cdot}0005\,T$. From the excess of the values of the specific heat beyond 1,450° over the calculated numbers, and assuming that the heat of dissociation of the chlorine molecule is —118,000 cals., the formula—

$$\log(1 - x^2)/x^2 = 118{,}000/4{\cdot}571\,T - 1{\cdot}75 \log T + \log P - 8,$$

is deduced for temperatures higher than 1,450°, $x$ being the degree of dissociation. T. H. P.

**1342.** *Contact Potential-differences Determined by means of Null Solutions.* **S. W. J. Smith** and **H. Moss.** (Phil. Mag. 15. pp. 478–497, April, 1908. Paper read before the Physical Soc., Feb. 28, 1908.)—The authors discuss Palmaer's measurements of the contact potential between mercury and N/10 KCl solution and the validity of the Lippmann-Helmholtz theory of electrocapillarity. It is shown by the experiments of the authors that the p.d.'s between different null solutions and mercury are not the same. This was proved by allowing for the contact p.d. between the electrolytes, by measuring each p.d. against the p.d. Hg/KCl, and also by measuring one null solution against another. This result can also be deduced from the electrocapillary curves. If the null solution p.d.'s are assumed to be zero, the values obtained for the p.d. Hg/*n*/10 KCl varies from about 0·58 volt to 0·79 volt, and if the p.d. at the electrocapillary maximum is most likely to be zero, when the maximum is undepressed, then in all probability the p.d. Hg/*n*/10 KCl does not exceed 0·58 volt. The polarising e.m.f. required to produce the max. surface tension between mercury and a given electrolyte has been proved by Paschen to be equal to the e.m.f. of the corresponding dropping electrode circuit, and this was shown by the authors to be true in four particular cases in which each e.m.f. is equal to zero. It was shown that the Paschen relation fails when the chemical action at the drop electrode, due to atmospheric oxygen, becomes appreciable. The Paschen e.m.f. between Hg/KCl remained unaltered when a solution of small quantities of $Na_2S$ was added, although the natural p.d. between mercury and the KCl solution was thereby altered by more than half a volt. A critical percentage of $Na_2S$ was found, for which the natural p.d. mentioned above, altered with extreme rapidity, as in the cases studied by Behrend, in which the variation of the e.m.f. $Hg/Hg_2(NO_3)_2$ produced by the addition of KCl or KBr at one electrode, was observed. In the present case the change in p.d. of Hg/electrolyte was deduced directly from the electrocapillary curves. F. J. B.

**1343.** *Alkali Electrode.* **P. T. Muller** and **H. Allemandet.** (Journ. Chim. Phys. 5. pp. 533–556, 1907. Electrician, 61. p. 95, May 1, 1908. Abstract.)—In order to investigate the behaviour of yellow mercuric oxide in dilute alkali solution, and the possibility of employing this substance as a depolariser, the authors have studied the chain—

$$Hg \mid HgCl + KCl \mid KNO_3 + KHO + HgO \mid Hg.$$

In the alkali electrode pure mercury was used, covered with mercuric oxide, and to this was added the solution of alkali (Li, Na, K, Tl, Ba, Sr or calcium hydroxide), along with N/10 potassium nitrate to increase the conductivity of the electrolyte. Connections were made through N/10 potassium chloride to a decinormal calomel electrode. The normal calomel electrode of Ostwald gives a remarkably constant value, but the decinormal electrode introduced by Richards varies between 0·6168 and 0·6175 volt, according to the method of making up; the latter electrodes can, however, be used after preliminary standardisation. Potential readings, corrected for the diffusion factors in the various alkalies, are given for N/10 to N/1000 solutions of the alkali hydroxides. The values for potassium hydroxide are, on the average, 0·0015 volt higher than the others, this being accounted for by the influence of potassium nitrate on the ionisation of potassium hydroxide. From this deviation the affinity constant of potassium hydroxide is calculated to be 1·87, which value is given with some reservation. T. H. P.

**1344.** *Constant and Economical Modification of the Daniell Cell.* L. **Saudino.** (Accad. Sci. Torino, Atti. 43. 8. pp. 242–245, 1907–1908.)—To prevent copper sulphate diffusing to the zinc electrode, where zinc sulphate is formed, causing loss of both copper sulphate and zinc, and lowering of the e.m.f. by the formation of a small secondary current, the author separates the two liquids of the cell by a paste of lead peroxide placed in an annular space, 10 mm. wide, between two thin porous pots. Such a cell has been examined by several authorities, who find the e.m.f. to range from 1·05 to 1·10 volt. After 20 days no trace of copper salt had reached the zinc pole, and when placed in a circuit with a resistance of 13 ohms the e.m.f. did not vary more than 1/100 volt during 1,000 hours. There is a saving of at least 0·50 lira (5d.) in the working cost per cell, and 73 elements will do the work of 100 of the ordinary type. W. H. St.

**1345.** *The Iron-Nickel Peroxide Accumulator.* II. *The Electrolyte.* F. **Foerster.** (Zeitschr. Elektrochem. 14. pp. 285–292, May 22, 1908. Laborat. f. Elektrochemie u. physikal Chemie d. techn. Hochschule, Dresden.)—During the charge the electrolyte is concentrated at the iron electrode and diluted at the nickel peroxide electrode; the opposite holds for the discharge. The experiments were made with two Edison $E_{18}$ cells, and also with very small cells consisting only of two nickel pockets and an iron electrode. The electrolyte was 4·6-N caustic potash. The density of the electrolyte was before the discharge, 2 days after the discharge, and 4, 9, 17 days after the discharge: 1·2133, 1·2354, 1·2382, 1·2400, 1·2411 respectively. Thus the rise in the density following the discharge is not momentary, but lasting. In a charged accumulator the density of the electrolyte also slowly rises a little when at rest because the iron decomposes some water. There is a loss of water during the discharge and the completion of the charge owing to the liberation of electrolytic gas. The changes in the concentration of the electrolyte are mainly due to the discharge of water from the positive electrode during the charge, and its reabsorption during the discharge. The e.m.f. decreases when the concentration increases; this is shown by the experiments with the small cells and by vapour-pressure calculations after Dolezalek. [See also Abstract No. 1745 (1907).] H. B.

**1346.** *Is the Activation of Atmospheric Nitrogen in Electric Gaseous Discharges a purely Thermal Process?* **G. Brion.** (Zeitschr. Elektrochem. 14. pp. 245–251, May 1, 1908.)—This question has been answered in the negative by Haber and Koenig [Abstract No. 185 (1908)], who recommend cold arcs for the fixation of nitrogen. It is difficult to give an explanation of the mechanism of the union of nitrogen and oxygen to which objections cannot be urged.

The author discusses the various forms of electric discharges in gases with the help of the so-called "characteristic" curve. The total heating of the gas, calculated on the amount of nitric oxide formed, is much lower than that actually observed. It is pointed out that all thermal considerations depend on the applicability of the law of mass action, which is an integral law, and consequently assumes a large number of similar neighbouring particles. But with electric discharges this is generally not the case; the smaller the number of particles influenced uniformly by the energy-centres—that is, the smaller the current density—the more reasonable appears the application of any equilibrium law. T. H. P.

**1347.** *Condensation Products of Ethylene and Acetylene obtained by means of the Dark Electric Discharge.* **M. Z. Jovitschitsch.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2b. pp. 1245–1254, Oct., 1907.)—The author describes condensation products obtained by subjecting ethylene and acetylene to the action of a current of 8 amps. at 100 volts in the apparatus previously described by Lozanitsch and Jovitschitsch [Ber. Deut. Chem. Gesell, 30. p. 135, 1907] and now termed a synthetisor. T. H. P.

**1348.** *Electrolytic Oxidation of Copper.* **F. Schmiedt.** (Elektrochem. Zeitschr. 15. pp. 53–56, June, 1908.)—When a concentrated solution of NaOH (10–14 normal) is electrolysed, using a copper anode, a higher oxide (peroxide) of copper is formed as a brown paste, as has been shown by Müller and Spitzer. By using a divided cell and comparing the oxygen evolved at the anode with that which should theoretically be evolved by the current passed, and by measuring the oxygen which is evolved and the $H_2O_2$ which is formed when the contents of the cell, after electrolysis, are treated with dilute sulphuric acid, the author comes to the conclusion that the higher oxide is a mixture of either $CuO_2$ or $Cu_2O_3$ with CuO and $Cu_2O$.

T. S. P.

**1349.** *Preparation of Electrolytic Iron.* **R. Amberg.** (Zeitschr. Elektrochem. 14. pp. 326–328, June 12, 1908.)—The author gives details of a process by means of which he obtains electrolytic iron of 99·9 per cent. purity. The bath used consisted of ferrous sulphate to which the equivalent quantity of ammonium sulphate had been added, and contained 15–45 gm. Fe per litre. The anodes were of soft steel and the kathodes of black sheet-iron. It was necessary to use a canvas diaphragm round the anodes, and to stir the electrolyte vigorously; the surface of the electrolyte was covered with a solution of paraffin wax in paraffin oil in order to prevent oxidation. The temperature was 20–50° C. With a kathode current density of 0·2–0·65 amp./dm.$^2$, and a voltage of 2·5–6, the latter depending on the distance apart of the electrodes, 3–5 kw.-hours were necessary for the deposition of 1 kg. of iron. Further experiments are in progress, using ferrous chloride as the electrolyte and diaphragms of Pukall's ware. The chloride is preferable to the sulphate, since it is more soluble, and the anode does not become passive so readily.

T. S. P.

**1350.** *Is the Law of Mass Action Valid for the Silent Discharge?* **M. Le Blanc** [experiments by **J. H. Davies**]. (Zeitschr. Elektrochem. 14. pp. 361–366, July 3, 1908.)—The author has shown [Abstract No. 1428 (1907)] that the law of mass action holds for the combustion of nitrogen in the high-tension arc flame, and investigates now whether the law still applies when the gas mixture is placed in an electric field at a temperature at which equilibrium is no longer purely thermal. A Siemens ozoniser, a U-tube of glass of about 25 c.cm. capacity, is exposed to alternating currents of from 2,000 to 10,000 volts; the coatings consist of mercury, sulphuric acid, or salt solutions. The tube is charged with hydrogen and nitrogen, specially purified, or with ammonia to study the reaction, $3H_2 + N_2 \rightleftharpoons 2NH_3$. The discharge should in the dark be visible as a pale glow; an excess of hydrogen does not alter the colour, an excess of nitrogen changes it into violet. Starting from pure ammonia, the decomposition is sensitive to variations in the current intensity and potential; an increase of one-third in the current intensity doubles the constant. But as the constant becomes smaller with an increasing percentage of hydrogen (*i.e.*, too little ammonia is decomposed), and greater with an increasing percentage of nitrogen, the constant is only slightly altered even when as much as 80 per cent. of the ammonia has been decomposed. This result is confirmed by experiments on the combination of mixtures of H and N in different proportions; with an excess of H the amount of ammonia remaining when equilibrium has been attained was found greater, and in the other case smaller, than the law of mass action would demand. Special experiments were conducted with a gas mixture of stoichiometrical proportions. The ammonia yield is greatest in the first moments of the reactions, but never technically promising. The velocity of the electrical reactions does not appear to be much increased at higher temperatures. Reference is made as regards this conclusion to Haber and König, and as regards the experiments to Pohl and Falckenberg. H. B.

1351. *The Nature of Supertension.* II. **F. Kaufler.** (Zeitschr. Elektrochem. 14. pp. 821–826, June 12, 1908.)—In reply to E. Müller [Abstract No. 845 (1908)], the author points out that Nernst's formula for the electrode potential $\pi = (RT/nF)\log(P/p)$ holds only for reversible processes, which implies that the energy developed must be a maximum or the energy absorbed a minimum. This does not apply when we decompose water under different conditions, and gas pressures can hence not be calculated by this formula. In the kathode potentials we have, moreover, to deal with transition resistances. When sulphuric acid is electrolysed with electrodes of lead-foil and the supertension afterwards destroyed by adding copper sulphate to the electrolyte, we find that there is with supertension always a transition resistance which depends upon the surface condition of the electrode, and is a function of the current density, while the resistance of the cell, in the absence of supertension, is the same whether the current be flowing or not. When a certain current density is exceeded the supertension remains constant. The explanation is that some badly conducting substance (probably a hydride, as Haber, Russ, and Tafel assumed), is formed and re-decomposed on a kathode of pure lead; as long as the current intensity is low the re-decomposition is more rapid than the formation, and the resistance at first increases with increasing current density; afterwards, however, the generation of gas helped by the heat evolution, breaks the badly-conducting film, and the resistance approaches that of the cell when not under current. The presence of traces of other metals favours the formation of local circuits, the hydrogen generation, and the decrease of the resistance. Certain organic reductions and oxidations, generally supposed to require supertension, can be effected with specially heated kathodes of platinised Pt, and a further experiment is described in order to prove that a kathode under supertension is hotter than the same kathode of lead-foil after the addition of copper sulphate. The heating is confined to the electrode by its gaseous envelope; the author does not suggest that the whole electrolyte becomes hot. Reductions are not dependent upon the kathode potential; the potential merely indicates that a certain reaction occurs at the boundary of electrode and electrolyte. H. B.

**1352.** *So-called Silver Peroxide.* **G. Baborovsky** and **B. Kuzma.** (Zeitschr. Elektrochem. 15. pp. 196–197, April 10, 1908.)—When silver nitrate solution is electrolysed, using a Pt anode and a current density of 0·07 amp./cm.$^2$, small crystals are formed at the anode which have been described as a silver peroxide. The authors regard it as probable that a difficultly soluble silver pernitrate, $AgNO_4$, is first formed, and that this undergoes secondary decomposition into the peroxide. This view is supported by the observation that, when the current is interrupted, a substance is found at the anode containing 1 mol. of nitric acid per atom of silver, whilst 2 mols. of free nitric acid (per atom of silver in the precipitate) are found in the anode solution: $3AgNO_3 + H_2O = 2Ag + 2HNO_3 + AgNO_4$. T. H. P.

**1353.** *Electro-reduction of Hydroxylamine.* **V. Rothmund** and **O. Flaschner.** (Zeitschr. Anorg. Chem. 58. 2. pp. 183–188, May 25, 1908. Physikal.-chem. Inst. d. k.k. deutsch. Univ., Prag.)—The authors reply to Tafel and Hahl [Abstract No. 520 (1908)] concerning the criticisms of the latter on Flaschner's work on the electrolytic reduction of hydroxylamine at copper kathodes [Abstract No. 1261 (1907)]. They point out that the only real difference of opinion is as to which apparatus is the best to use. Accurate results can only be obtained when the electrolyte is stirred and the potential measured during the course of an investigation, *i.e.*, when Flaschner's and not Tafel's method is used. The onus of proof lies with Tafel, since with Flaschner's apparatus it has been proved that hydroxylamine is reduced at copper kathodes. [See also Abstract No. 1763 (1902).] T. S. P.

## REFERENCES.

**1354.** *Preparation of Aluminium Carbide.* **C. Matignon.** (Annal. Chim. Phys. 13. pp. 276–288, Feb., 1908.)—The full paper corresponding to Abstract No. 1940 (1907).

**1355.** *Vapour-pressure of Sulphur at Low Temperatures.* **C. Ruff** and **H. Graf.** (Zeitschr. Anorg. Chem. 58. 2. pp. 209–212, May 25, 1908. Anorg. u. Elektrochem. Laborat. d. Kgl. techn. Hochschule, Danzig-Langfuhr.)—The discrepancies between the authors' and Gruener's values [Abstract No. 176 (1908)] for the vapour-pressure of sulphur are attributed to differences in apparatus and mode of work. A revised table is given of the vapour-pressure of sulphur between 49·7° (0·00034 mm.) and 211·3° (3·14 mm.). D. H. J.

**1356.** *Experimental Examination of Gibbs's Theory of Surface-concentration: Application to the Theory of Dyeing.* **W. C. M. Lewis.** (Phil. Mag. 15. pp. 499–526, April, 1908. Paper read before the Physical Soc., Feb. 28, 1908.)

**1357.** *Influence of Ozone upon the Condensation of Water Vapour.* **G. Leithäuser** and **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 10. 6. pp. 249–255, March 30, 1908.)—The paper is a preliminary one only, and is unsuitable for abstraction. The original must be consulted for details. F. J. B.